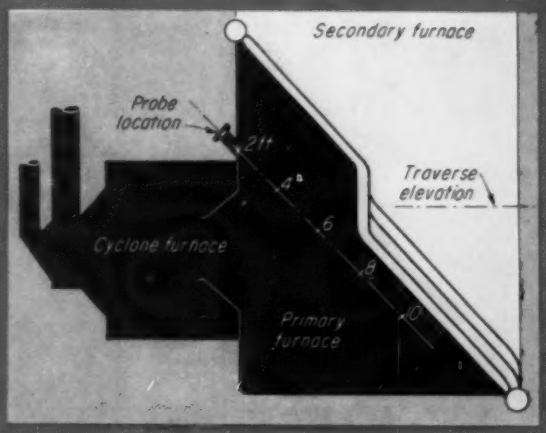
For engineers who design and manage the power and plant services

# Power

APRIL 1960

ONE DOLLAR

A McGRAW-HILL PUBLICATION

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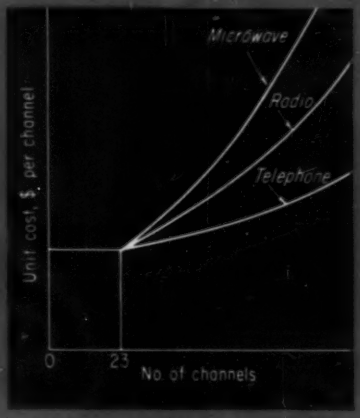


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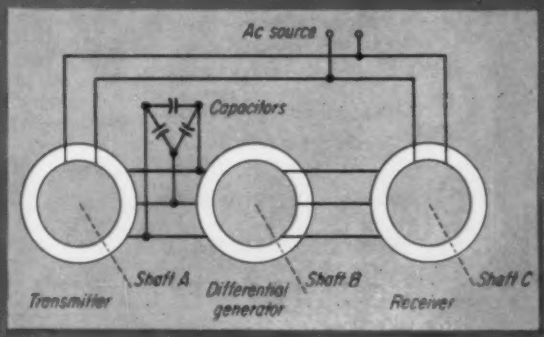


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a *TD* report

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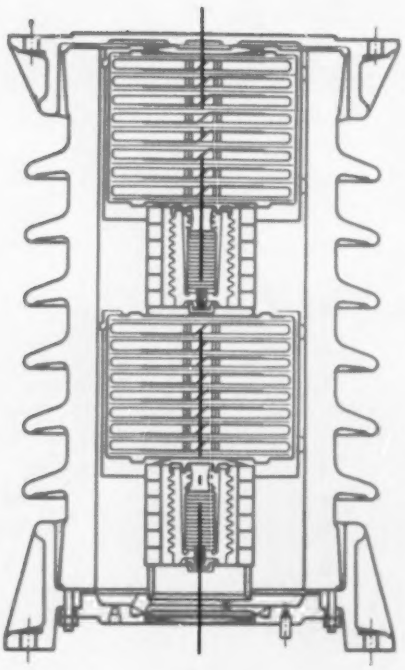

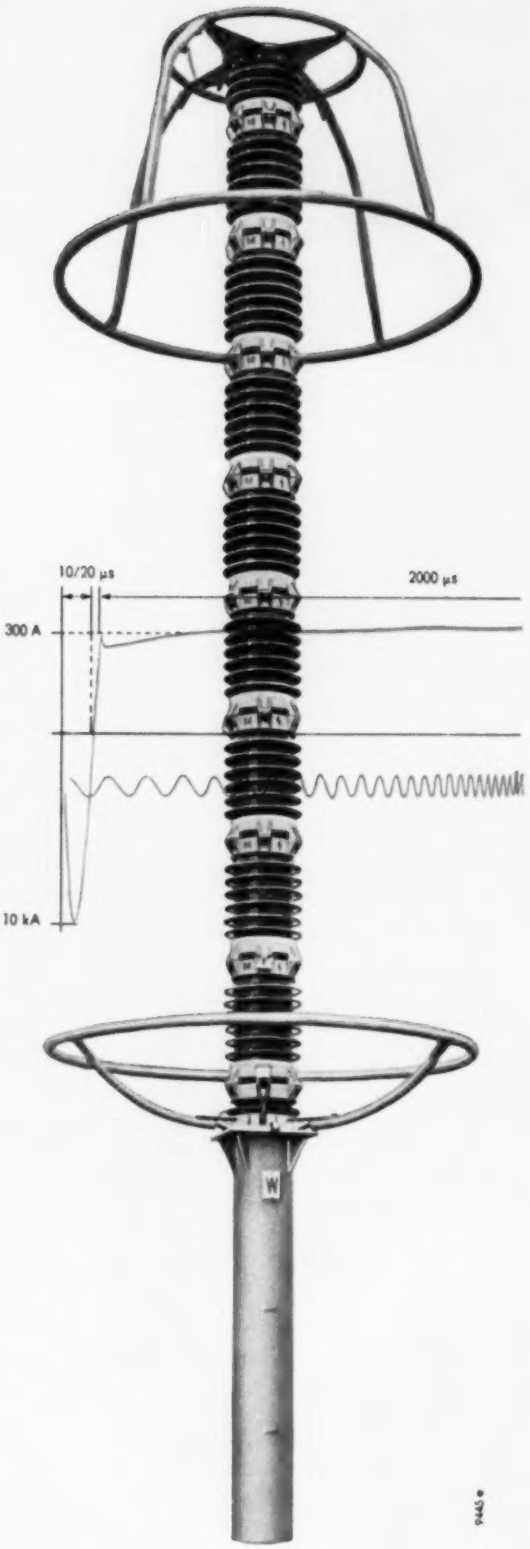


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of self-supporting design
for highest voltages

## Type SAWFV

Voltage rating 340 $kV_{r.m.s.}$
50% Breakdown voltage 730 - 860 $kV_{(max)}$
(1/50 µs wave)
Residual voltage < 1155 $kV_{(max)}$
(discharge current 10 kA)

**ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT**
Berlin (West) EXPORT DEPARTMENT Frankfurt (Main)

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THERE'S POSITIVELY
NOTHING LIKE NEW GOODYEAR

positive drive

# BELTS

## –for positive assurance of quality in maximum-efficiency belts

*With Goodyear quality Positive Drive Belts now at your disposal, you're free to explore all these new avenues in machine or appliance design –*

SMALLER SIZE – With Goodyear Positive Drive Belts, you can use smaller pulleys – shorter centers – narrower belts of higher capacities. Center distance can be permanently established.

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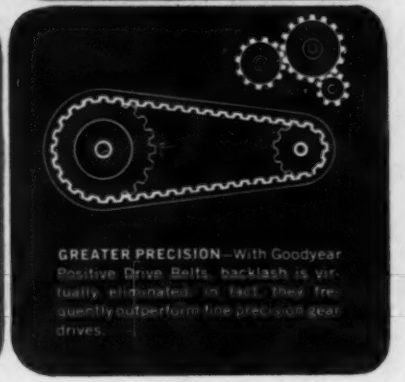

GREATER PRECISION – With Goodyear Positive Drive Belts, backlash is virtually eliminated – in fact, they frequently outperform fine precision gear drives.

**And remember – Positive Drive Belts are designed and built to the famed Goodyear high standards of quality. For full details on belts for drives from fractional to 600 H.P.–for speeds up to 16,000 f.p.m., contact the G.T.M. – Goodyear Technical Man. He's available through your Goodyear Distributor – or by writing Goodyear, Industrial Products Division, Lincoln 2, Nebraska, or Akron 16, Ohio.**

Goodyear Positive Drive Belts are manufactured under license and according to U. S. Patents 2,507,852 and 2,397,312.

POSITIVE DRIVE BELTS BY

# GOODYEAR

THE GREATEST NAME IN RUBBER



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## *speaking of* **Power**

**Editorial planning,** as you might suspect, goes on constantly. However, once every year we sit down at an all-day meeting away from the office, to examine our day-to-day operations in perspective and lay plans for the months ahead. Just such a meeting took place recently in New York's Manhattan Hotel. Coming special reports, *TD* reports, new departments and the Plant Design Issue were some matters discussed. What are the editors doing now about making these plans a reality?

Right now Assistant Editor Ted Edwards is in Florida, and will hit Louisiana and Texas, tracking down field data for a special report on piping and fittings in the June issue and checking out an article on condenser tubing. At the same time staffers Jim O'Connor and Lawson Stewart are in Pittsburgh studying the most recent work of the Allegheny County Air Pollution Control Bureau. Their findings will serve as part of the background data for a major air-pollution report in December.

**Power-to-grow,** our editorial program dealing with industrial electrical-distribution-system design, is one of Associate Editor Norm Peach's concerns as he swings through Ohio, Missouri and Minnesota. And in a short while Associate Editor Bob Bellas will be visiting with consultants and industrial-plant staff engineers on the West Coast, laying groundwork for the October Plant Design Issue. Bob will also study the many-faceted problem of atmospheric contamination in California.

Down in Houston we find Associate Editor Ben Skrotzki attending the ASME Gas Turbine Power Conference. His next stop will be the Westinghouse Research Labs in Pittsburgh to gather data for next month's *TD* report. Subject: Research developments in the power field. Meanwhile, Associate Editor Steve Elonka is tackling the practical aspects of vibration isolation in preparation for a special report this summer.

As James H McGraw Sr said, the good editor wears out the soles of his shoes, not the seat of his pants.

Lou Lowley


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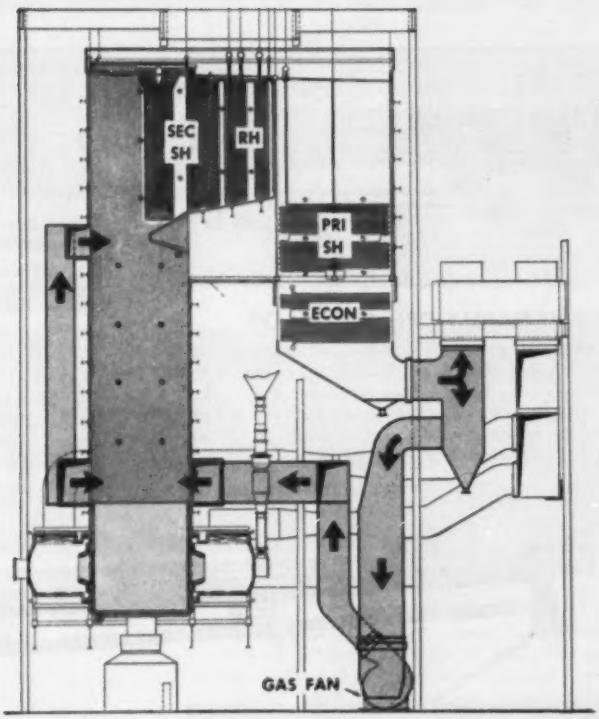
# "105 Years" on-the-line Prove B&W Gas Tempering




**Introduction of "cool" flue gases near furnace exit prolongs superheater tube life, reduces superheater maintenance, cuts alloy requirements, and prevents slagging with even low grade coals.**

105 years of unit generating experience is B&W's proof that gas tempering is the better way to provide an advanced degree of superheater tube protection.

Gas tempering in these boilers protects superheater tubes from excessive gas temperature, eliminates "enameling" of molten slag on tube convection surfaces — a major problem in burning low grade coals — reduces superheater maintenance and permits economies in over-all plant construction.

In a drum type or a B&W Universal Pressure® Boiler, gas tempering offers the solution to many vexing and often cost-building problems. For an analysis of gas tempering, and illustrations of its application, write for bulletin G-96. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

G-960

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BOILER DIVISION



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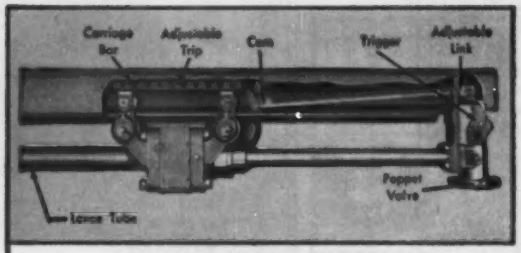
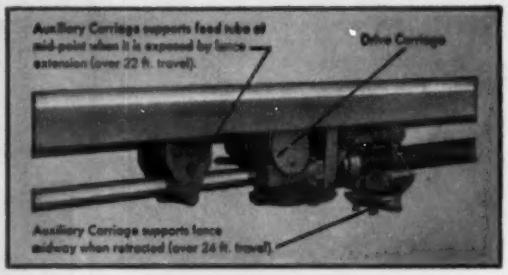
# *Reasons* FOR THE ENTHUSIASTIC ACCEPTANCE



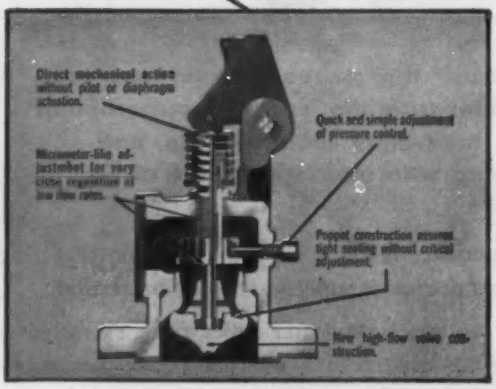

### MECHANICALLY OPERATED VALVE

Control of blowing medium is automatic, positive and accurate by means of a simple, dependable mechanically operated valve. As lance begins movement into boiler, trip on carriage opens valve through a linkage. At end of retraction, trip closes valve. All pilot or diaphragm valve elements are eliminated. Trip is adjustable.


Auxiliary Carriage supports feed tube at mid-point when it is exposed by lance extension (over 22 ft. travel).
Drive Carriage
Auxiliary Carriage supports lance midway when retracted (over 24 ft. travel).

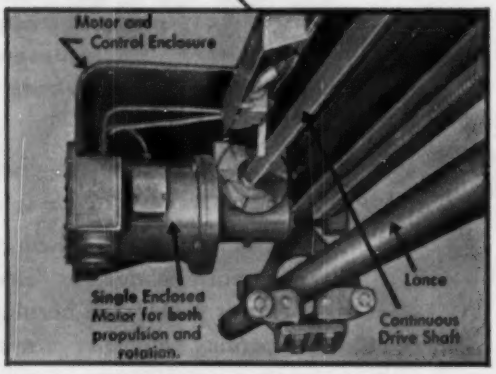
### AUXILIARY CARRIAGES (FOR EXTRA LONG TRAVEL)

On extra long blowers, one auxiliary carriage supports lance midway when retracted, preventing undue bending. Second auxiliary carriage is dropped at mid-point to support feed tube when it is exposed by lance extension.


Direct mechanical action without pilot or diaphragm actuation.
Micrometer-like adjustment for very close regulation at low flow rates.
Quick and simple adjustment of pressure control.
Poppet construction assures tight seating without critical adjustment.
New high-flow valve construction.

### POPPET VALVE WITH ADJUSTABLE PRESSURE CONTROL

Diamond dependable poppet valve with improved streamlined flow contours and adjustable pressure control that permits easy, accurate setting of pressure at individual valve and independent of other blowers. Poppet construction assures tight seating without critical adjustment. Stem, seat and disc are stainless steel. Stellited seating surfaces are available.




### STATIONARY GEAR MOTOR

Lance propulsion and rotation are by a *single* enclosed gear motor which drives a continuous shaft running the full length of blower and providing power to carriage. This construction makes it possible to mount motor in a fixed position at the front end for better protection and accessibility.

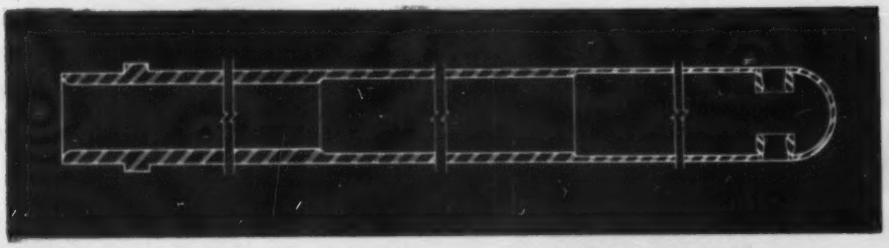
8077

DIAMOND POWER

# of the DIAMOND SERIES 300 IK
# LONG RETRACTING BLOWER

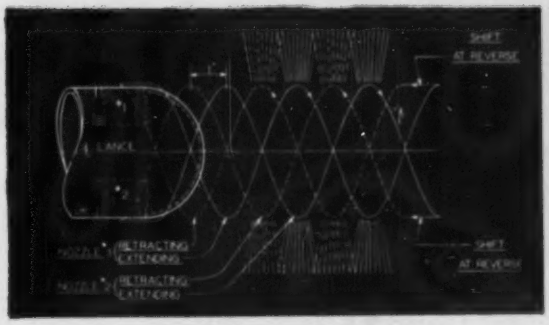
**The Diamond Series 300 IK Blower sets a new and higher standard of efficiency, economy and dependability in the cleaning of heating surfaces that require a long retracting lance type blower. Pointed out in detail are some of its important features. Others are a *single* outboard support point to simplify installation and the attractive "backbone" cover for greater rigidity and protection of the entire blower assembly from dirt, damage, the elements and personnel hazards.**

**This new Series 300 IK is the culmination of more than 20 years' experience building and applying long travel blowers. It well illustrates the Diamond design philosophy: *"Keep it simple . . . keep it basic . . . avoid unnecessary complications."* It is further evidence of the fact that YOU CLEAN BOILERS BETTER AND AT LOWER COST WITH DIAMOND BLOWERS.**



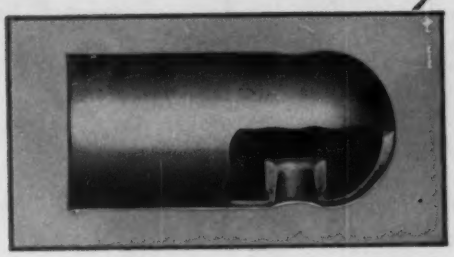
**STEP-TAPER LANCE**
**(FOR EXTRA LONG TRAVEL)**

Extra long lance has minimum droop due to step-taper construction which employs up to four different wall thicknesses. Lightest wall is at nozzle end to reduce bending moment. Lance is chrome alloy for heat resistance.




**IMPROVE CLEANING PATTERN**

Close and positively controlled helical cleaning pattern assures maximum cleaning effectiveness. Blowing pattern diagram illustrates how return travel path is exactly intermediate with forward travel path so that there is a *positive nozzle sweep every inch.*



**IMPROVED DIAMOND NOZZLE**

New design Diamond "Type A" Nozzle is the result of several years' research and the testing of more than 50 different contours. The modified venturi produces maximum impact pressure and cleaning effectiveness with minimum expenditure of cleaning medium. (Steam or compressed air.)

***For further information, ask the nearest Diamond office or write directly to Lancaster for Bulletin 2111U.***

**SPECIALTY CORP.** **LANCASTER, OHIO**
DIAMOND SPECIALTY LIMITED—Windsor, Ontario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# You get these benefits YARWAY GUN-PAKT

Why do industrial plants, institutions, universities and central heating plants SPECIFY and INSTALL Yarway Gun-Pakt Expansion Joints?

Because with Yarway you get:

- **CONTINUOUS SERVICE**

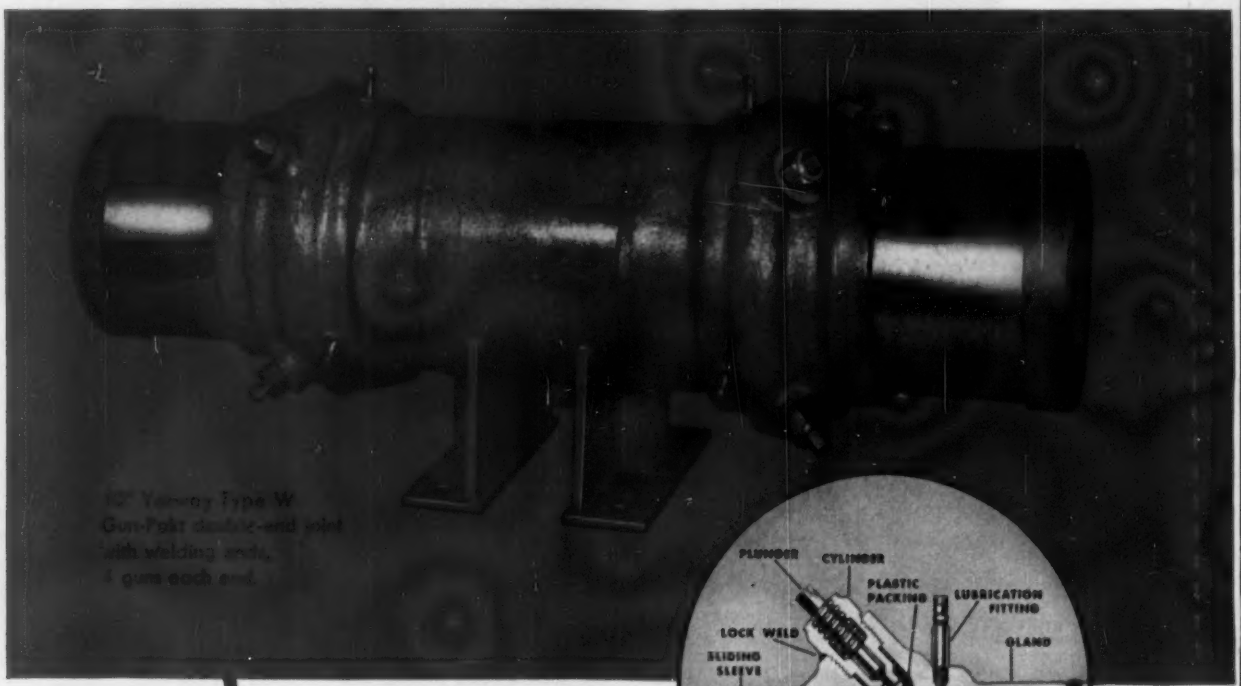
  Costly shutdowns are eliminated. Packing is seldom necessary but may be added *under full line pressure*. No vents are necessary. Never needs repacking.

- **RUGGED DEPENDABILITY ALL STEEL CONSTRUCTION**

  Durable chromium plated seamless steel sleeves. No chance *of metal fatigue*. Wrought steel bases provide rugged, positive anchorage.

- **INTERNAL AND EXTERNAL GUIDES**

  Positive alignment of sleeve in stuffing box—*where it counts!*




Cross-section of Gun-Pakt feature. To add packing, just insert a plug and turn the plunger. Note non-return packing slots.

# when you install EXPANSION JOINTS

**● LIGHT WEIGHT, STREAMLINED DESIGN**

Requires less space to install—less space to maintain—smaller manholes.

Many Gun-Pakt joints have been *in service over 25 years with only nominal maintenance* —no major repairs or periodic overhauls. Maintenance costs are negligible—records show average to be one manhour and 65 cents worth of packing per joint per year. AND—NEVER A SHUTDOWN FOR REPACKING!

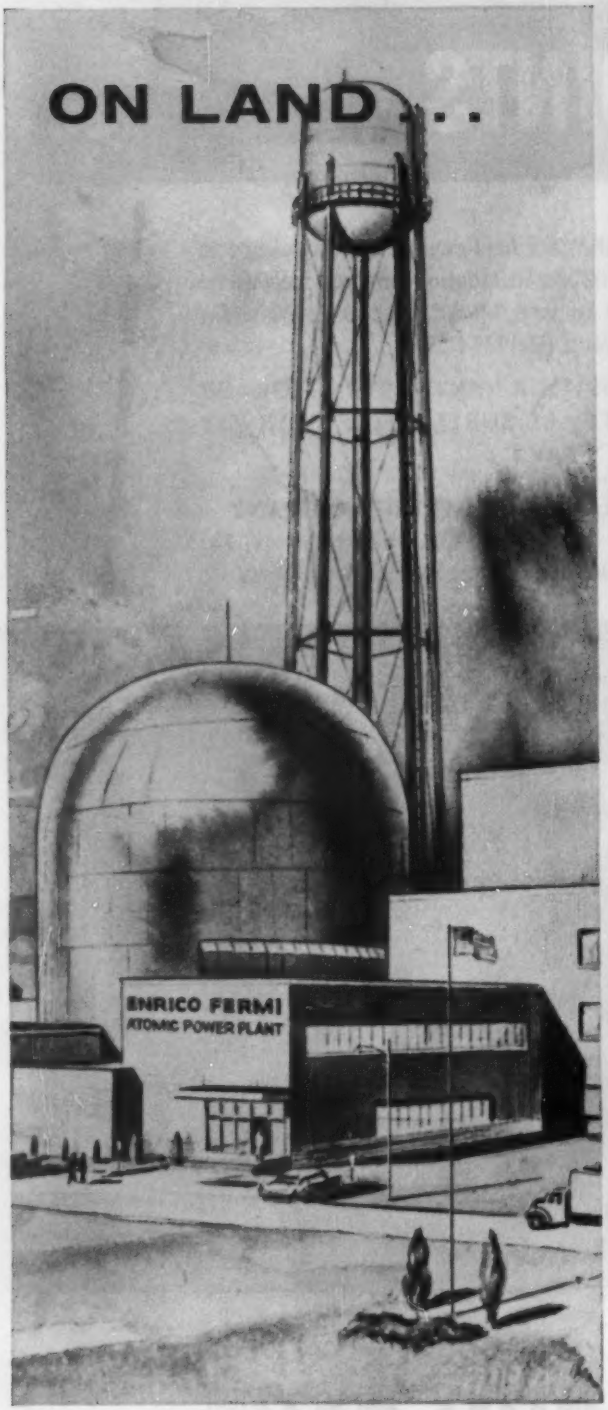
YARWAY field engineers are qualified to advise on installation and service—at no cost to you. Investigate today. Write for Bulletin EJ 1917 ('59).

FOR YOUR NEXT PIPELINE JOB—BE SAFE—BE SURE! SPECIFY YARWAY GUN-PAKT.

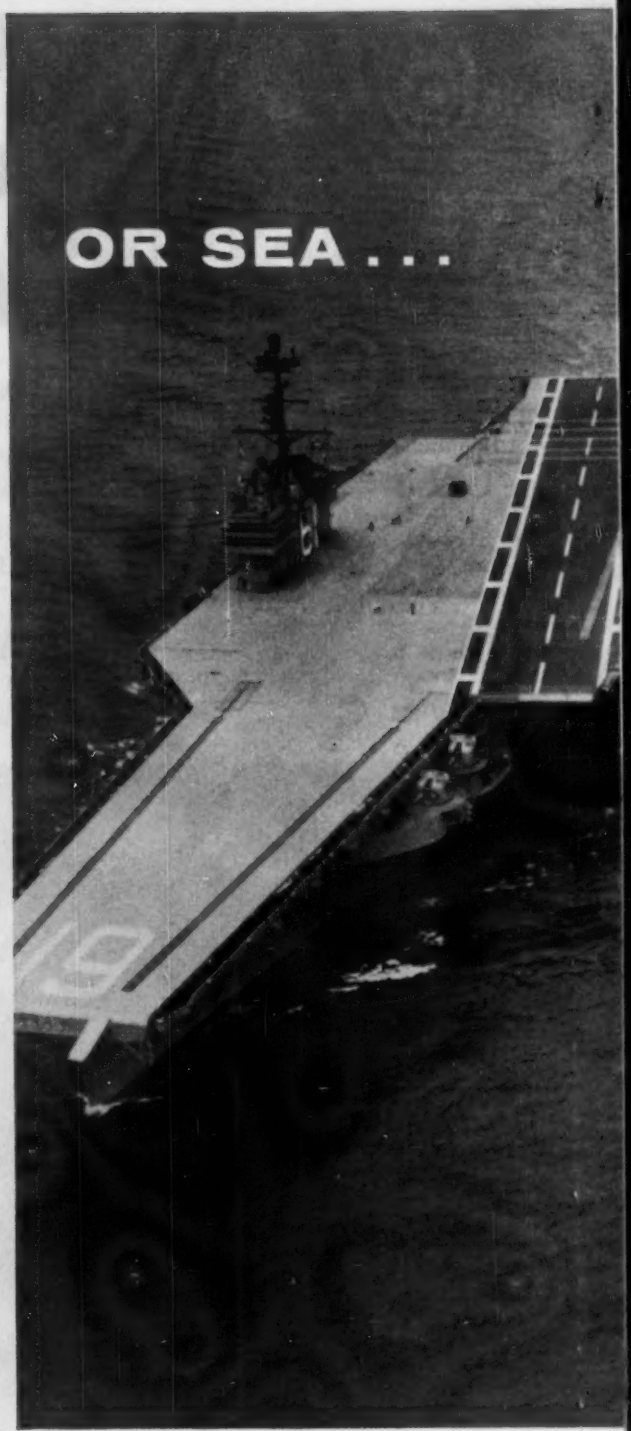
**YARNALL-WARING COMPANY**
100 Mermaid Avenue, Philadelphia 18, Pa.
*BRANCH OFFICES IN PRINCIPAL CITIES*

20" Yarway Type W Gun-Pakt single-end joint with welding ends, 8 gage.

# YARWAY® GUN-PAKT



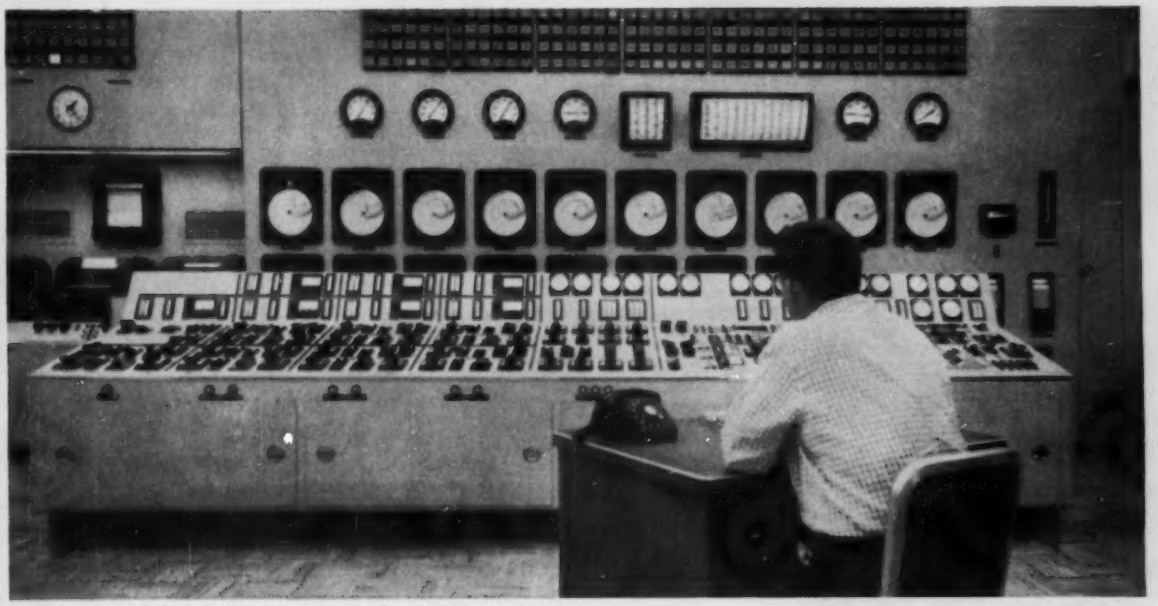

At the Enrico Fermi Atomic Power Plant, instruments and controls for both the "fast neutron breeder" reactor and the steam plant which it will "fire" are being furnished by Bailey.




Many of the new ships such as this super-carrier, USS Ranger, operate their boilers by Bailey Meter Control. Cargo ships, tankers, and passenger liners as well as Naval ships improve the economy and safety of their steam plants thru use of Bailey controls.

At the Thomas H. Allen Electric Generating Station of the City of Memphis, Tenn., Bailey operating indicators and controls for combustion, feed water, and steam temperature are centralized on the mechanical benchboard directly ahead, while the operating records which reflect trends are mounted on the vertical boards. A Bailey METROTYPE Information System, center left in the photo, scans, monitors, and logs functions usually assigned to strip-chart recorders.

# IT'S BAILEY. . .



## for the latest and safest instruments and controls for nuclear and conventional power plants!

Many of the power plants of the future will have controls and instruments designed and built by Bailey. There are two reasons: Bailey's continuing research and development toward the latest equipment for industry's needs; Bailey's 40-year association with the hardware and economic requirements of the industry.

If you are planning new or improved power plant facilities, call on Bailey engineers to assure that your system will have the *proper balance both as to economics and needs . . . that there will not be the unnecessary expense of over-instrumentation or control . . . nor the duplication of equipment functions.*

Call on Bailey for primary sensing devices, indicators, loggers, control units, panels, data handling equipment, computers for performance analysis, and supervisory controls. You'll find designs ranging from conventional to the most sophisticated . . . mechanical, pneumatic, electric and electronic, including solid state.

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A144-2

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For more facts circle 208 on Reader Service card, p 133

# the F/A Motor saves you time and money!

Scheduled inspections and cleanings that result in longer life for your large motors are now easier, less expensive and--for the first time—accomplished with motor parts in *full view!*

The Westinghouse F/A Motor can be prepared for routine inspection, examined, and be back in operation in 10 minutes. For planned yearly inspections, complete disassembly and reassembly take only an hour.

**Routine or Weekly Inspection.** It takes just three minutes to prepare for this inspection. Merely removing the side panel completely exposes the leads, winding ends and rotor air ducts. A quick cleaning takes care of any contaminants. In four minutes the side panel is back on, and the F/A Motor is in operation.

**Detailed Annual Inspection.** Such a complete disassembly as is shown at the right, above, is rarely done, because in conventional motors it is virtually impossible. However, with the Westinghouse F/A Motor it *can* be done, and in just half an hour! No other housing design permits such

see-ability and accessibility. Here you can *completely* check windings and bracing, examine the ends of the rotor, check the condition of the *total* core and check all bolts for security. Necessary cleaning can be done in minutes, and with a thoroughness heretofore impossible. Then, in roughly 30 minutes, reassembly of side panels, top air shields, end covers and top enclosure puts the F/A Motor back "on the line."

For full information on the long service life, reliability and accessibility of the Westinghouse F/A Motor, call your Westinghouse representative or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa. J-15003

## CHECK THESE BONUS VALUES IN THE F/A MOTOR

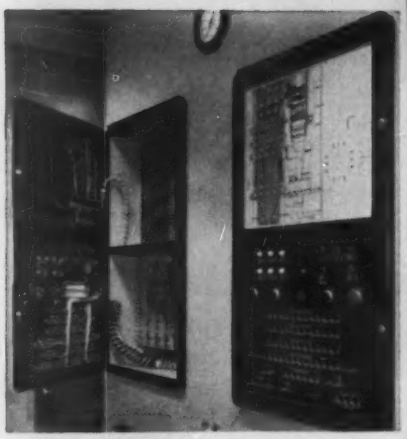
- Full Accessibility
- Inherently Quiet—housing and stator separated
- Thermalastic® Insulation—recognized as the finest
- Time-Proven Components—longer, more efficient life
- Easy Connection—conduit boxes eliminated

YOU CAN BE **SURE**...IF IT'S

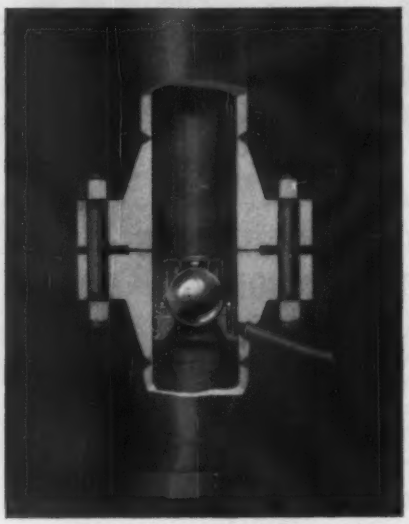
**Westinghouse**

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV ALTERNATE FRIDAYS

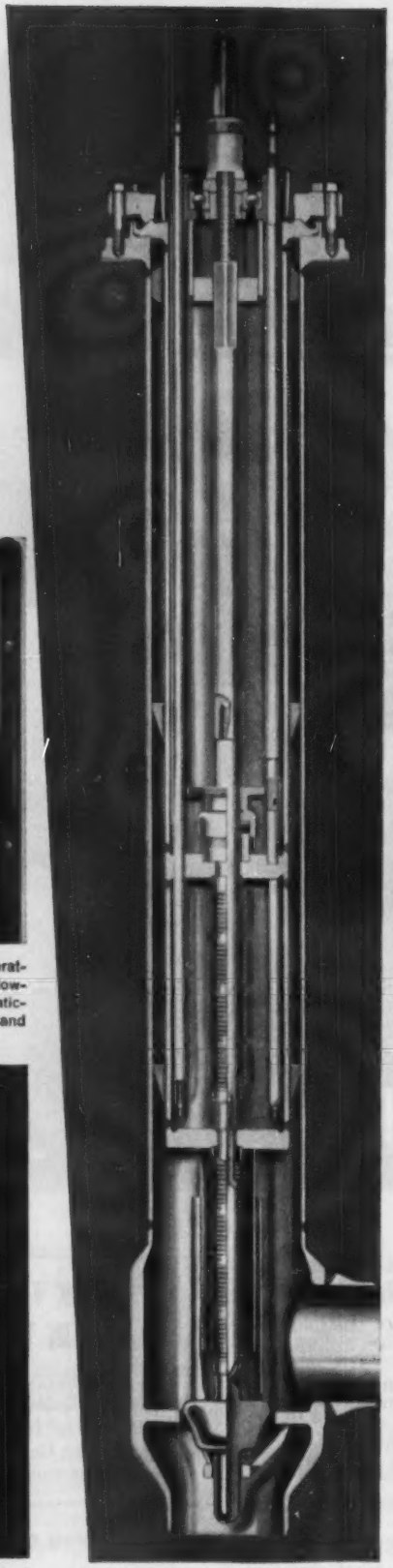
# Nuclear with



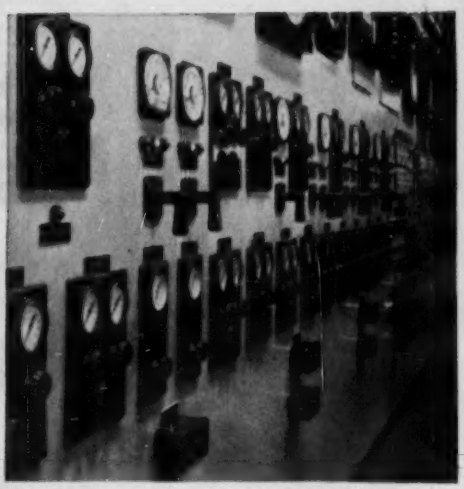
**Automatic soot blowing** permits varying the operating sequence of air- or electrically-driven soot blowers. Vulcan Selective-Sequence and Automatic-Sequential systems assure positive cleaning, and save blowing medium. Write for Bulletin 1029.



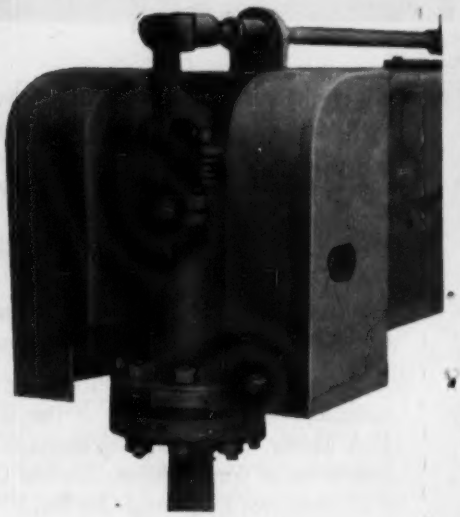
**Variable-Orifice Desuperheater*** holds reduced steam temperature constant close to its outlet. Write for Bulletin 1037. Carburetor and Steam-Assist types are also available for steam service conditions through 2500 psig and 1100 F. **Patent applied for.*



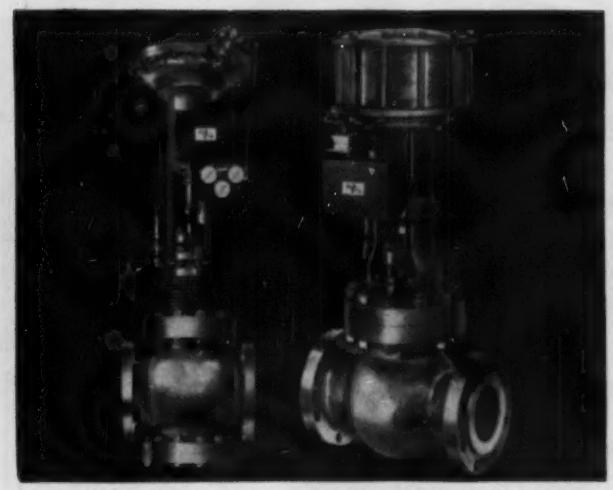
**Nuclear valves** meet rigid requirements for resistance to corrosion, fail-safe operation, and remote maintenance. Components are thoroughly cleaned and assembled in a sterile atmosphere.



**Boiler control** provides high-speed response. Combustion control may be from steam flow—air flow, or fuel-air ratio. Feedwater control from one, two, or three influences. Write for Bulletin 1038.



# *and fossil-fuel plants power up Copes-Vulcan equipment*



**Control valves** for flow, pressure, and temperature of fluids or gases are job-tailored for accuracy and dependability. Diaphragm- or piston-operated types are available in pressure standards from 125 through 2500 psig. Both offer excellent rangeability. Write for Bulletin 1027.

In conventional, super-critical, and nuclear power stations on land . . . aboard conventional and nuclear-powered ships at sea, Copes-Vulcan precision-built control systems increase efficiency.

Meeting exact design requirements, Copes-Vulcan builds control systems for combustion, feedwater, superheat and reheat steam temperatures, pressure reducing, desuperheating, and soot blowing.

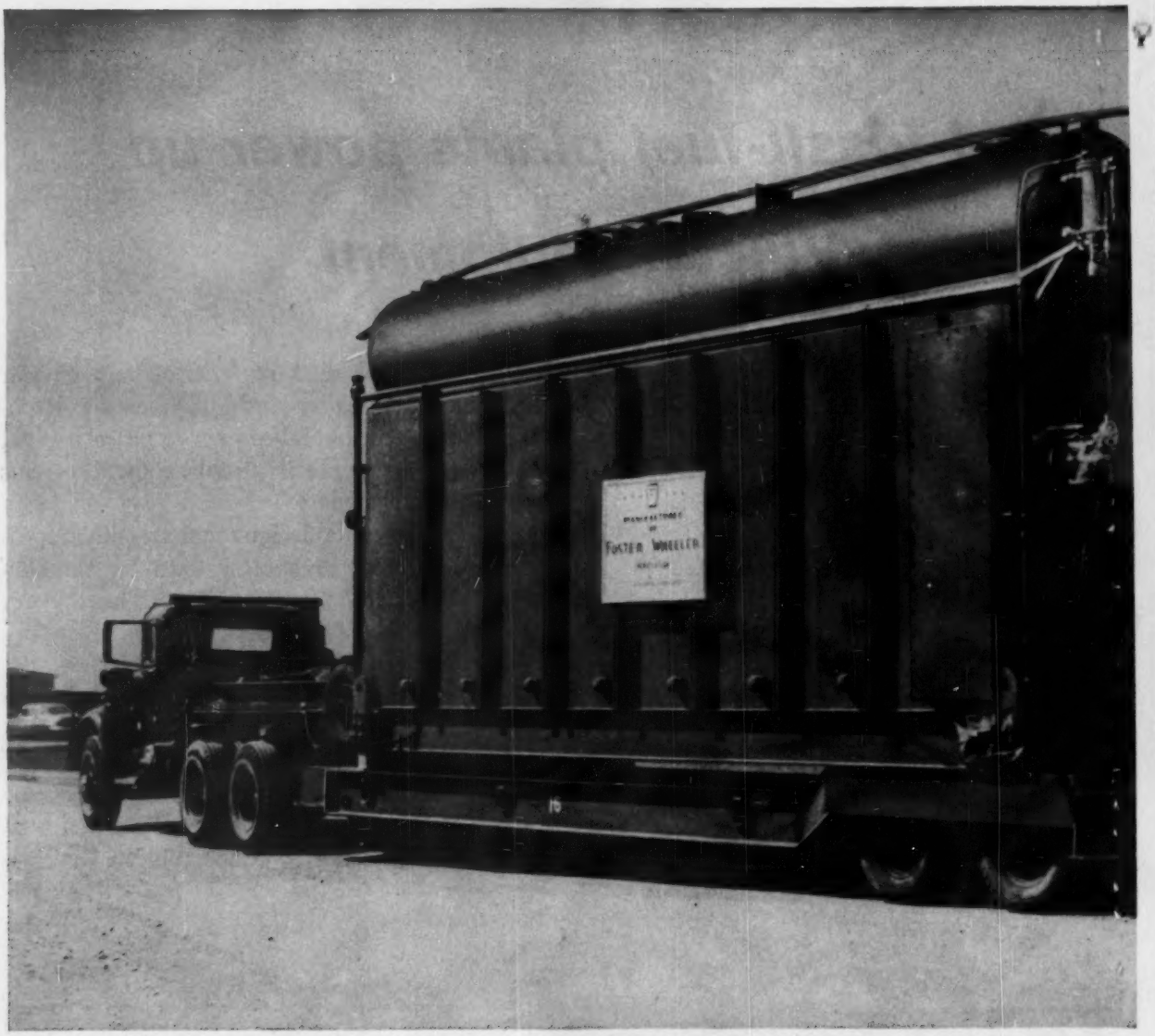
Copes-Vulcan is also experienced in the design and manufacture of such special products as nuclear valves.

All of these systems are custom-engineered. All are backed by more than 50 years of design experience. Copes-Vulcan Division, Erie 4, Pa.

**Extra-long soot blower,** Vulcan T-30, is built for travels up to 40 feet. Dual-motor drive gives multi-helix blowing pattern for thorough cleaning of all surfaces. All working parts encased for protection. Write for Bulletin 1030.

*Copes-Vulcan Division*

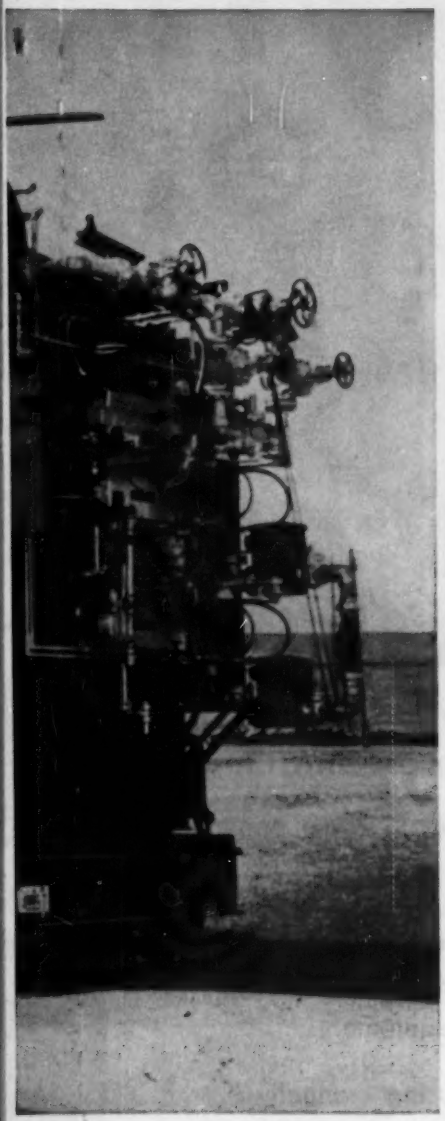
**BLAW-KNOX**




Foster Wheeler Packaged Steam Generator on its way to a refinery, where it is now producing 50,000 lb/hr of high-purity steam for processing and heating purposes.

—PETROLEUM PROCESSING

—CHEMICAL PROCESSING



# Foster Wheeler delivers the steam you need and the economy and efficiency you want, in one package

If you need 13,000 lb/hr or more of steam at pressures of 250 psi or above, one of the best ways to begin planning your steam generator installation is by contacting Foster Wheeler right now.

This is Foster Wheeler's record of experience in meeting steam requirements with packaged steam generators.

The first water tube shop-assembled packaged unit was built by Foster Wheeler in 1940, to solve an important defense problem. Today, standard Foster Wheeler Packaged Steam Generators, firing fuel oil and gas separately or in combination, are serving refineries, process and manufacturing plants, hotels, dairies . . . virtually every type of business and industry throughout the world.

Most recent Foster Wheeler development in packaged steam generators is a stoker fired model, the first available to industrial users of steam.

In short, the *heat engineering* experience that goes into Foster Wheeler Packaged Steam Generators is unique in the power industry. And the result is a product engineered for dependable, economical and efficient production of high-purity steam . . . and delivered as a package which keeps installation costs to a minimum.

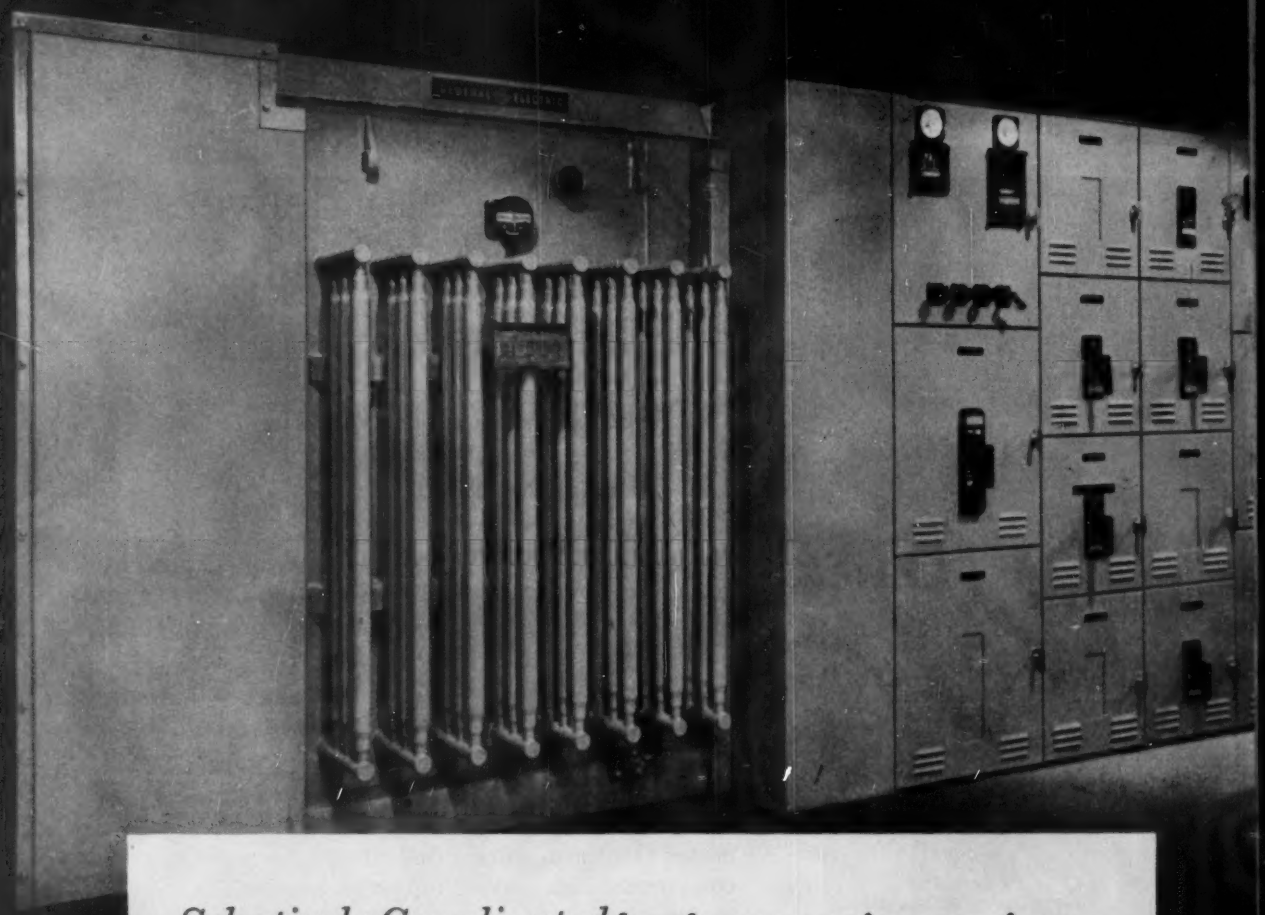
Make planning your steam generator installation easier by getting full information on Foster Wheeler Packaged Steam Generators *before* you start writing your specifications. Write Foster Wheeler Corporation, 666 Fifth Ave., New York 17, for Bulletin PG-58-2. Or better still, contact Foster Wheeler directly and discuss your steam requirements personally with one of Foster Wheeler's *heat engineering* specialists.

*Heat Engineered* products, plants and processes . . . for the world's power, petroleum and process industries.

—SPECIALIZED INSTALLATIONS

FOSTER WHEELER

NEW YORK LONDON PARIS ST. CATHARINES, ONT.



## *Selectively Coordinated* load centers give maximum service continuity . . . and now cost you less

1. SAVE UP TO $600 PER BREAKER because General Electric has eliminated the price premium for selective trips when supplied with G-E switchgear equipments.

2. SAVE UP TO $630 PER BREAKER by using manually operated, stored-energy breakers in place of electrical units formerly required.

**Total savings vary from $465 to $930 per breaker, depending on size.**

**How much can you save? Ask your General Electric sales engineer.**

## General Electric *Selectively Coordinated* Load Center Unit Substations now are . . .

# Yours at Lower Cost

***YOU NOW PAY LESS***

You can purchase G-E *Selectively Coordinated* load center unit substations at new low prices. General Electric has eliminated the price premium normally charged for this inherently higher-cost, more highly-engineered product. This means that you can now get superior service for the same price as the more common, but less "intelligent," fully-rated load center unit substation. Further savings can be realized by the use of manually operated stored-energy breakers.

***SELECTIVELY COORDINATED LOAD CENTERS MINIMIZE DOWNTIME***

In the *Selectively Coordinated* load center, the tripping times of the main and feeder breakers are coordinated so that during short-circuit conditions, power is removed only from the faulted feeder. Power continues to flow to the unfaulted feeders—thus preventing costly, unnecessary downtime. (See diagram below.)

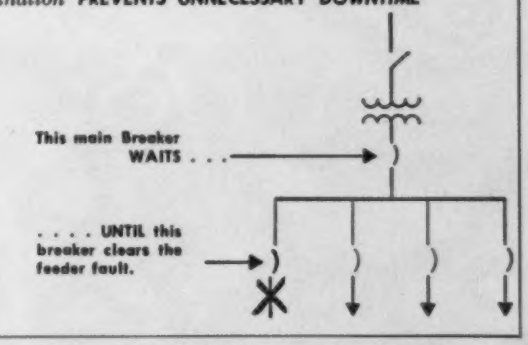
***SIMPLY SPECIFY SELECTIVE COORDINATION***

Order the *Selectively Coordinated* load center. Upon delivery, you will receive time-coordination curves which show you the factory-preset characteristics of each breaker, how they combine to assure you of the best possible service continuity.

For more detailed information, contact your nearest G-E Apparatus Sales Office or write to General Electric Co., Schenectady 5, N. Y. for bulletin GEA-3592. 211-01

***HOW Selective Coordination PREVENTS UNNECESSARY DOWNTIME***

**WITH G-E SELECTIVELY COORDINATED** load center unit substations, feeder breakers are adjusted to clear any magnitude of feeder fault. The selective main breaker preserves power continuity to unfaulted feeders.




*Progress Is Our Most Important Product*

GENERAL ELECTRIC

For more facts circle 212 on Reader Service card, p 133

# The Story of Edward Research

# and the Leak-proof Valve

In the early 1940's, the advance of steam power plant pressures and temperatures demanded a leak-proof, small sized valve—one with permanent tightness at the seat joint and one which would solve the failures of mechanical gasketed bonnet joints under elevated temperatures. The story behind the development of the Edward leak-proof Univalve* (sizes to 2½" in 1500, 2500 and 4500 lb. pressure classes) is the story of the product research that solved this industry problem.

**EARLY EXPERIMENTING:** Elimination of the bonnet joint entirely, by providing a one piece body-yoke construction, appeared to be a logical approach to the bonnet joint problem. But this created a new problem—how to apply and *how to service* an integral Stellited seat from a distant point at the top of the valve yoke. Some valve manufacturers chose to split the valve body near the seat and then reassemble the body with a full pressure weld. Others chose a full pressure weld at the normal bonnet joint position. Neither approach allowed the user to disassemble the valve and both approaches resulted in the sacrifice of a positive, permanent backseat—a desirable feature in any high-pressure valve. Edward engineers refused to make these concessions.

**ENGINEERS FIND SOLUTION:** After many attempts, Edward engineers developed a water-cooled welding torch for the application of the Stellite seat. This provided a stress-free Stellite layer of uniform density, firmly bonded to the body, free of cracks and pin hole porosity. Simultaneously, other Edward engineers sought the answer to the bonnet joint leakage problem. Extensive research and testing of a variety of body-bonnet combinations and seal-welding techniques resulted in the four elements of today's proven Univalve bonnet joint—a body-bonnet shoulder, load carrying thread, guiding section for alignment and the seal weld.

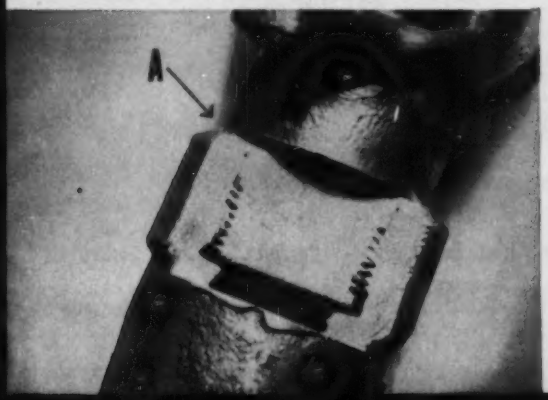
**NEW DESIGN PROVES OUT:** Months of research testing failed to find a weakness in the new design. Thousands of operations at rated pressure and temperature indicated long-time seat tightness superior to anything previously achieved. Bonnet joint design could not be made to fail at several times the valve rating. Tests were conducted with supercritical steam pressures up to 6000 psi at 1050 F in the only known facilities capable of producing those conditions at that time. And, to date, *hundreds of thousands of Univalves are in service with only one recorded instance of bonnet joint leakage*—a minor defect in the seal weld.

Edward builds a complete line of forged and cast steel valves from ½" to 18", in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs for pressures up to 10,000 lbs. For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1230 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

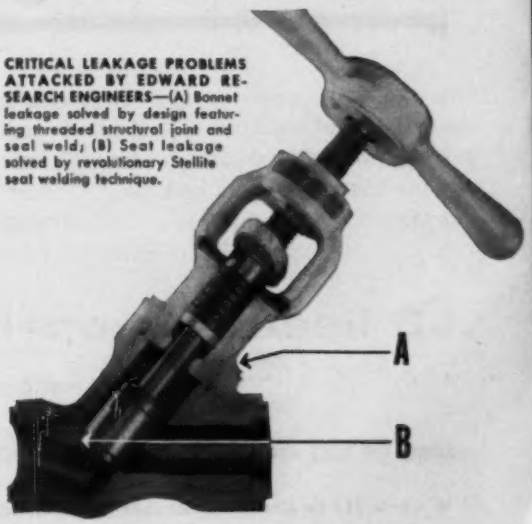
EDWARD STEEL VALVES
another fine product by
ROCKWELL

◀ E. A. STICHA, Chief Research Metallurgist, and R. K. Wagenblast, Research Engineer, measure temperature of valve seal weld in superheater test loop used in Univalve research.

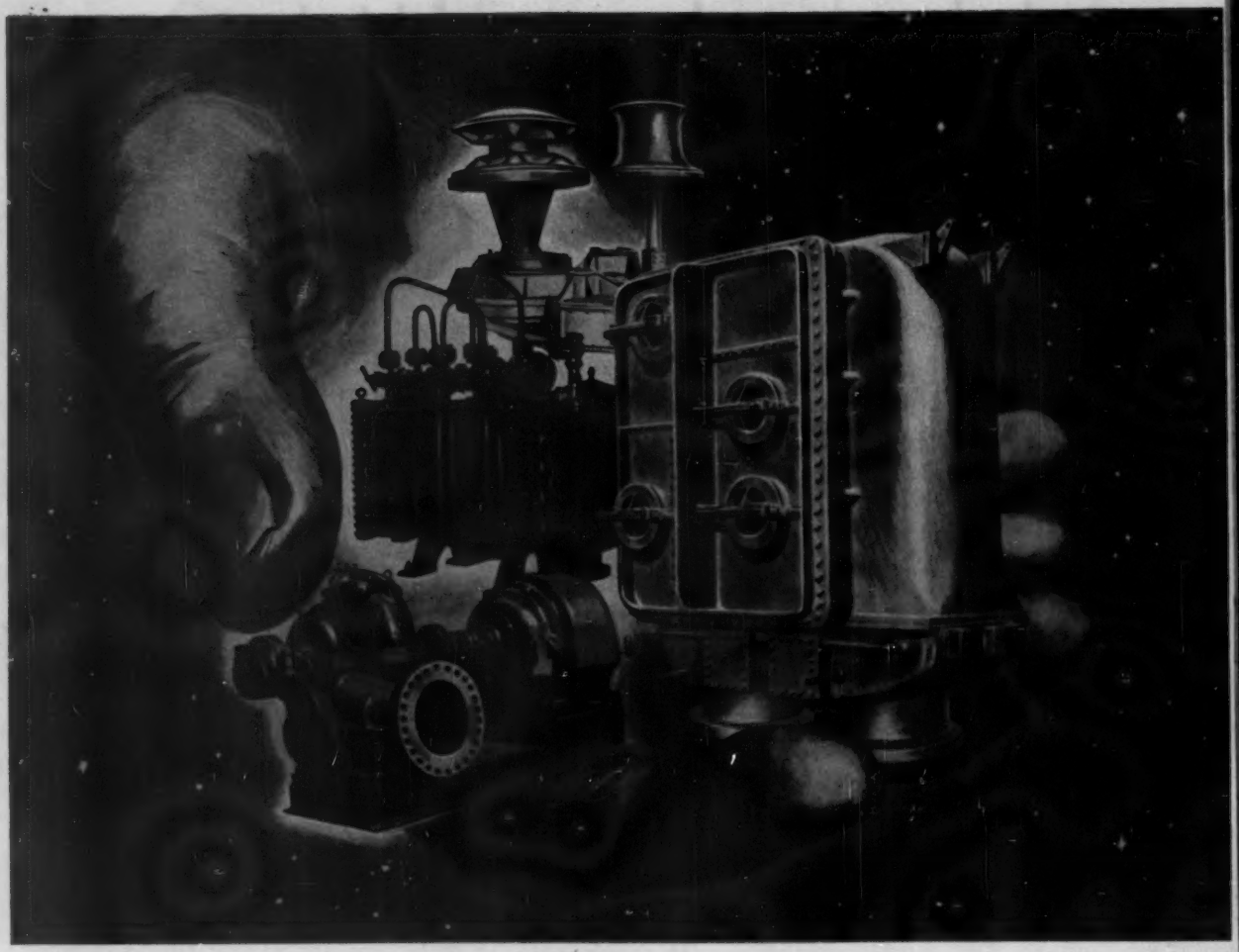
▼ **DESTRUCTION TESTS IN EDWARD LABORATORIES IN EARLY 1940's**—Bonnet seal weld (A) of test valve cracked only after body creep occurred at 200° F above primary temperature and four times the primary pressure.




**CRITICAL LEAKAGE PROBLEMS ATTACKED BY EDWARD RESEARCH ENGINEERS**—(A) Bonnet leakage solved by design featuring threaded structural joint and seal weld; (B) Seat leakage solved by revolutionary Stellite seat welding technique.




*T.M. Reg. U.S. Pat. Off.



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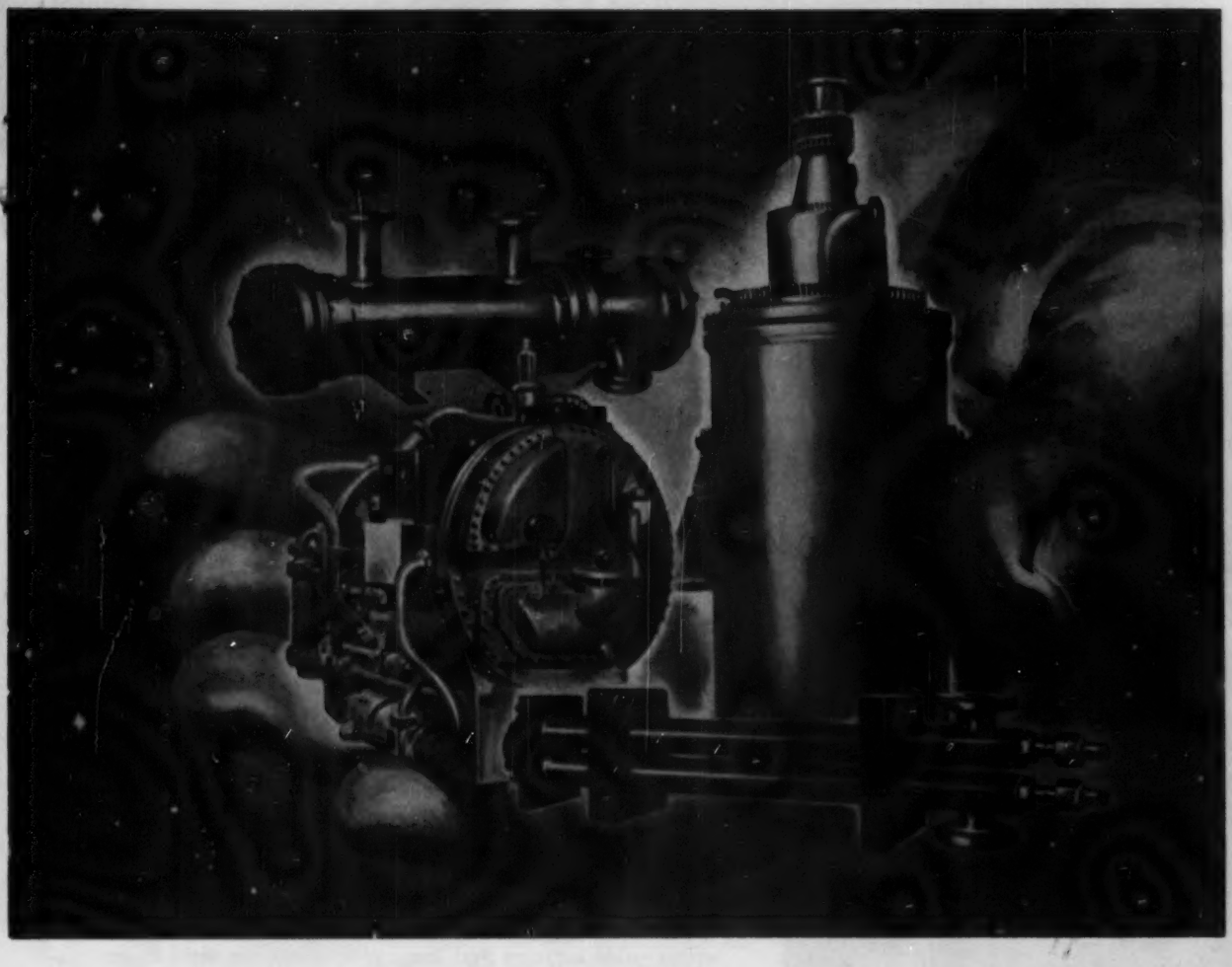
among the many components offered are: Condensers, Ejectors, Heat Exchangers — Bare Tube, Extended Surface Heat Exchangers,

◀ Circle 213 on Reader Service card for preceding ad



# C. H. Wheeler Mfg. Co. / Griscom-Russell Co.

lines offers important savings for management and engineering staffs engaged a variety of applications in power plants, marine, process and nuclear systems.

C. H. Wheeler Manufacturing Company, with 71 years' experience manufacturing condensers, ejectors, pumps and other components for the power, marine, process and nuclear industries, and Griscom-Russell, with 92 years' experience in the heat exchange field, are uniting to create an important pool of experience, products and services unmatched in industry today. The advantages offered by this combination are improved and increased selection, distribution and service, resulting in substantial savings for the current and potential customers of both companies.

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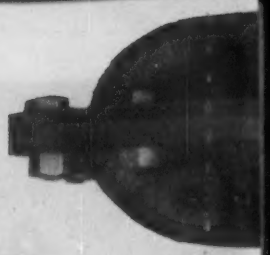
Evaporators, Marine Distilling Plants, Marine Systems, Pumps, Nuclear Components, Valve Actuators, Custom Fabrication and Machining

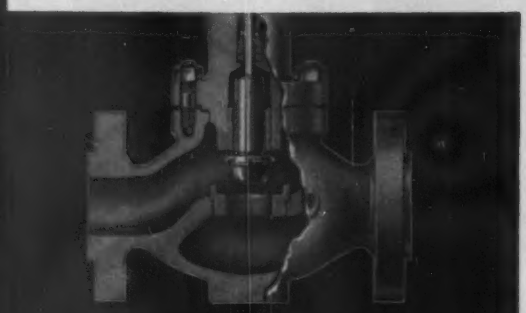


For more facts circle 214 on Reader Service card, p 133

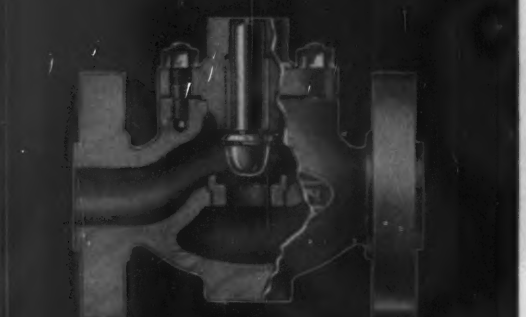
# Masoneilan 20000 Series Control Valves



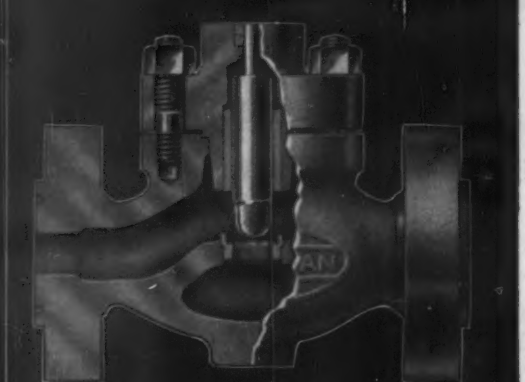
## The Most Versatile Single Seated Valves Available



Two inch, 600-body with full capacity plug.



Two inch, 1500 body with full capacity plug.



Two inch, 2500 body with full capacity plug.

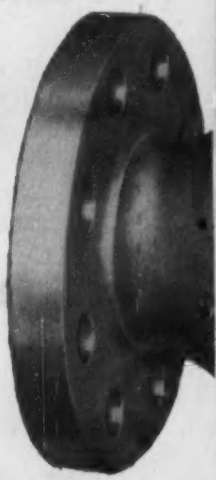
With the introduction of this new line of solid-cast control valves the advantages of single seat design become available for a substantially wider scope of application, from the simple to the most severe. Consider these premium features built in as standard, available to you at no extra cost.

- **High Capacity** — top guiding, unrestricted seat ring area, body and plug contours provide greater capacity than most top-and-bottom-guided double seated valves of comparable sizes.

- **High Pressures and Pressure Drops** — high capacity is attained with minimum seat ring areas, resulting in less unbalance force, permitting higher pressure drops. Heavy guiding throughout full stroke results in a minimum of unsupported plug length and allows high pressure and high pressure drop applications without lateral vibration. Generous guide surfaces and large plug stems are sized in accordance with body rating.

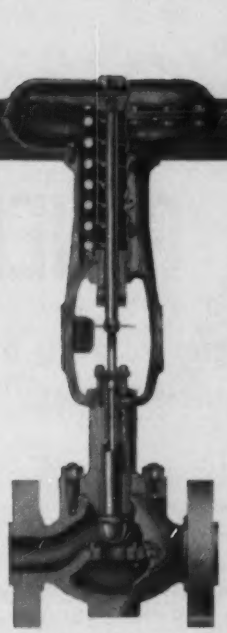
- **Wide Selection of Reduced Capacity Trim** — for those applications where velocity due to high drop is a consideration (or where future requirements for larger capacity are a factor) a wide selection of reduced capacity trim is available — and interchangeable in comparable valve sizes and ratings (see table). The proper relationship between stroke and trim size is maintained in order to provide the strongest possible plug tip, particularly in hard, brittle materials.

| Valve Size | Available Cv Ratings | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ¾ | 1.5 | 3.4 | 5.2 | 8 | | | | | | | |
| 1 | 1.5 | 3.4 | 5.2 | 12 | | | | | | | |
| 1½ | 1.5 | 3.4 | 5.2 | 12 | 25 | | | | | | |
| 2 | 1.5 | 3.4 | 5.2 | 12 | 25 | 46 | | | | | |
| 3 | | | | 12 | 25 | 46 | 110 | | | | |
| 4 | | | | | 25 | 46 | 110 | 195 | | | |
| 6 | | | | | | 46 | 110 | 195 | 400 | | |
| 8 | | | | | | | 110 | 195 | 400 | 640 | |
| 10 | | | | | | | | 195 | 400 | 640 | 1000 |



For more facts circle 215 on Reader Service card, p 133

Two inch, 600 lb. valve has size 11 actuator.



Two inch, 1500 lb. valve has size 13 actuator.

Two inch, 2500 lb. valve has size 15 actuator.

**Wide Selection of Materials** — the design of body and plug permits the use of suitable special materials to meet severe operating conditions.

**Suitable for Slurries** — body and plug contours (plus the fact that no bottom guiding is required) make these valves suitable for viscous fluids and slurries.

**Welding Ends Available** — the solid-cast body allows the use of welding ends. The removable bolted bonnet permits easy (only one joint to break) inspection or cleaning with valve in the line.

**Actuators Sized to Body Rating** — the standard spring-diaphragm (direct or reverse) actuator is sized according to body rating, thus minimizing requirements for oversize actuators in severe applications. Where extra high initial or final thrust is desirable, the judicious selection of actuator size and spring range enables the spring-diaphragm actuator to be used in most instances. For applications beyond the scope of the spring-diaphragm type, springless-diaphragm, cylinder or electric drive actuators are available.

**SPECIFICATIONS** — **Sizes:** ¼", 1", 1½", 2", 3", 4", 6", 8", 10"

**Ratings:** Steel — 150, 300, 400, 600, 900, 1500, 2500 lb. ASA
Iron — Class 125 or 250 ASA

**Connections:** Screwed ends — ¾"-2" in 600 lb. and Class 250 rating
Flanged — ¾"-10"
Welding ends available on steel valves.
Face-to-face dimension is I.S.A. standard.

MASONEILAN

# MASON-NEILAN

Division of Worthington Corporation
**33 NAHATAN STREET, NORWOOD, MASS., U.S.A.**
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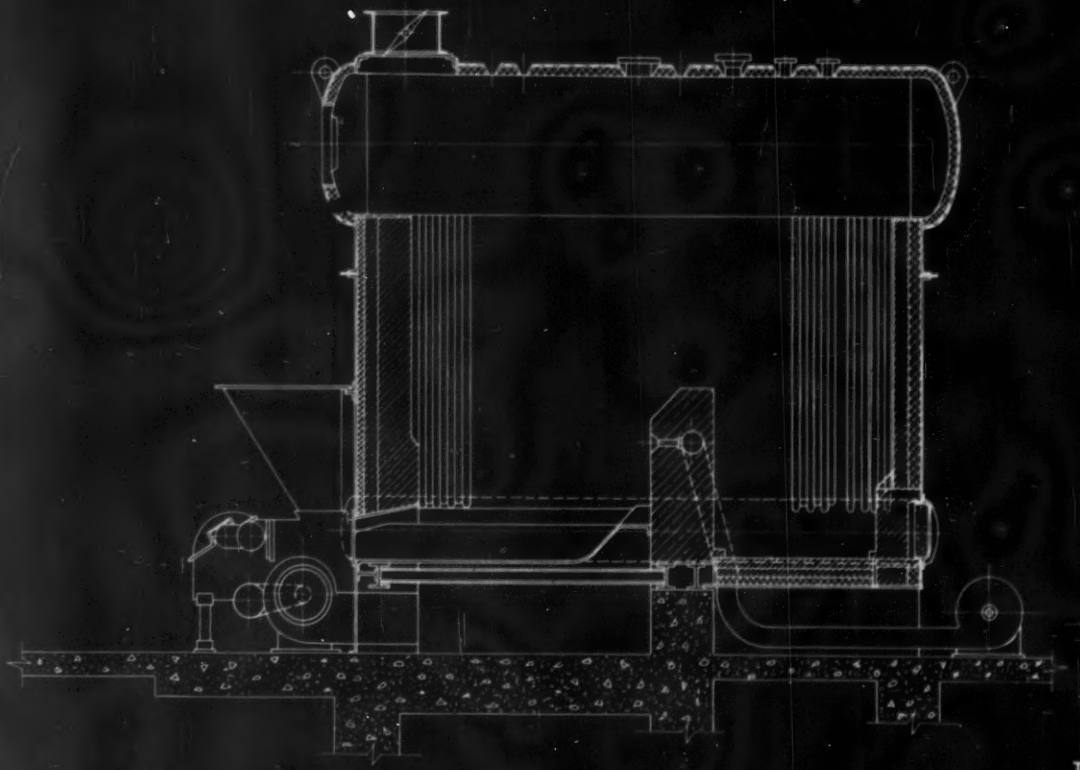
*you can take full advantage of the fuel situation with*

# WICKES

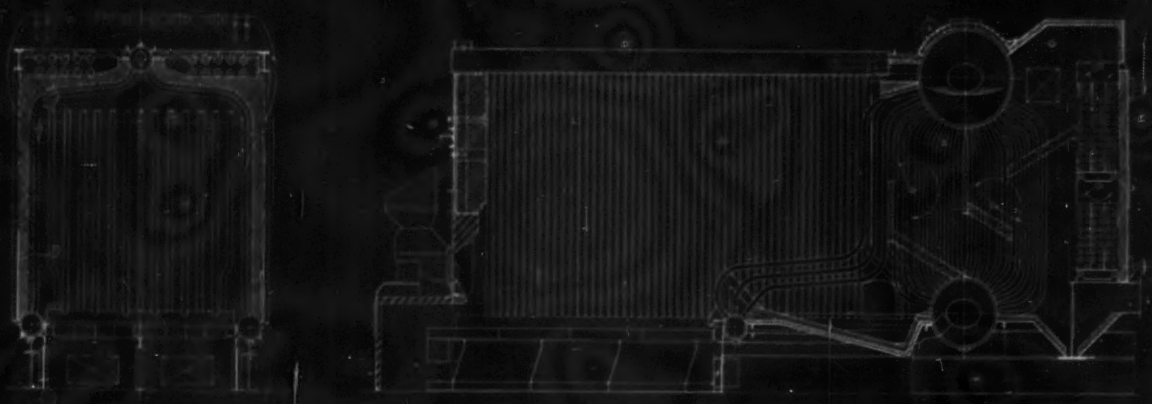
# PACKAGE STOKER-FIRED STEAM GENERATORS

**Designed and built to WICKES recognized standard of excellence, engineered to WICKES high standard of efficiency**

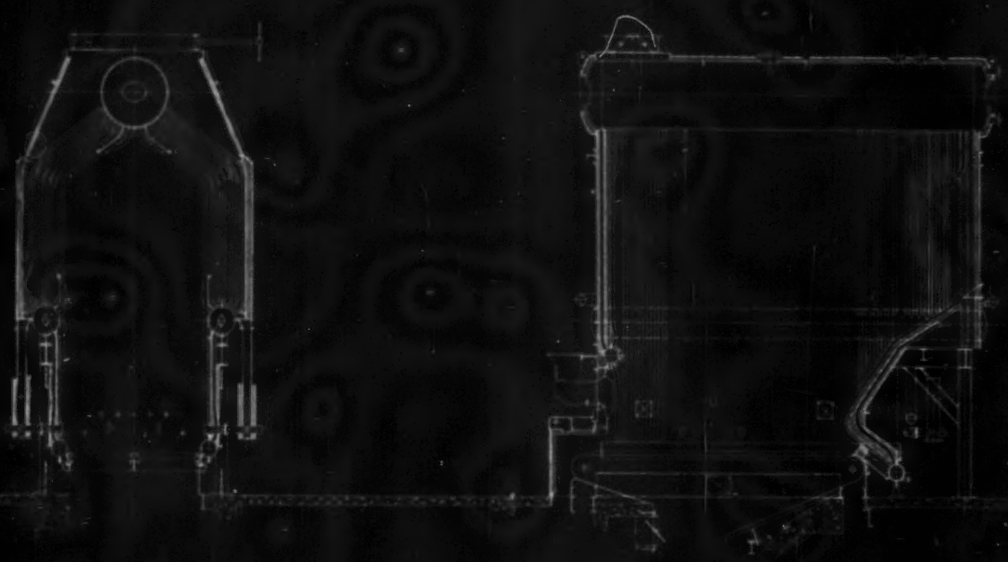
These stoker-fired WICKES generators are compact, package water tube boilers, custom-engineered to your exact steam generating requirements. Semi-automatic in operation and convertible from stoker-fired to either gas or oil fired, these WICKES generators are built to the highest standards of workmanship to give you the same efficiency of operation that you have come to expect from all WICKES-built boilers. They are built in a variety of designs to meet size, space and fuel conditions. For complete information on these WICKES stoker-fired units as well as the complete line of WICKES water tube steam generators, ask the WICKES sales representative nearest you to call . . . offices in principal cities*.



TYPE A



TYPE S-3



TYPE A

# WICKES

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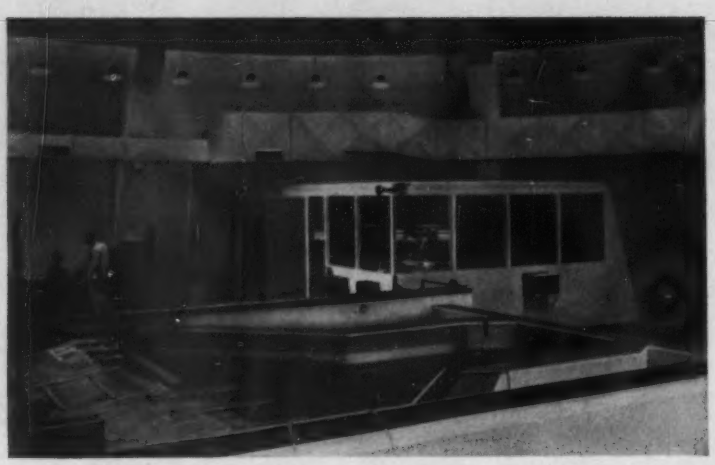
DIVISION OF THE WICKES CORPORATION

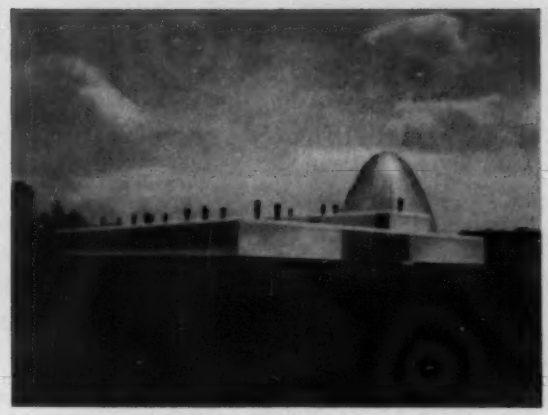
*at the "Atoms for Living" Center . . .*

# 10 companies share Honeywell



This view shows the top of the "swimming pool" and the reactor control room. A core of enriched uranium is located at the bottom of the pool, 30 feet below. 136,000 gallons of demineralized circulating water provide additional shielding and remove heat from the core when the reactor is operating.

Honeywell instruments for startup, linear, log N, and safety channels, along with auxiliary equipment, are mounted on the panel to provide good readability from the operator's position at the console. Rod drive, power set, range selector, rod position indicators, scram button, scram warnings, and secondary annunciator system are on the console within easy reach.



An 87-foot-high aluminum-sheathed concrete dome houses the reactor, and is designed to provide maximum safety from radiation hazards.

# instrumentation for safe reactor control

Ten non-competing industrial companies were in need of facilities for nuclear research in their respective fields of interest, so they pooled their resources to form Industrial Reactor Laboratories, Inc.—an "Atoms for Living" center near Plainsboro, N.J. Now, each company has at its disposal the world's largest privately owned nuclear research reactor—at one-tenth the cost of single-company ownership. IRL owners are American Machine & Foundry Company, American Tobacco Company, Atlas Powder Company, Continental Can Company, Corning Glass Works, National Distillers and Chemical Corporation, National Lead Company, Radio Corporation of America, Socony Mobil Oil Company, Inc., and United States Rubber Company.

The reactor is a 5-million-watt "swimming pool" type, designed and built by American Machine & Foundry Company. Like many major nuclear installations in the country, Industrial Reactor Laboratories use Honeywell instrumentation for safe, accurate, dependable control. In your own project, use Honeywell's extensive experience in control of nuclear processes—experience that includes design and construction of reliable components, building complete reactor control systems, and actual installation and startup. Call your nearby Honeywell field engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

75th YEAR — PIONEERING THE FUTURE

**Honeywell**

First in Control

SINCE 1885

# Picks coal

## International Paper now burns coal as low-cost fuel

When the International Paper Company—one of the largest paper companies in the country—made plans to double its production output, at its Mobile, Alabama plant, an engineering survey was made of power and steam facilities. This study indicated the need for increased boiler capacity. It was decided to install new modern coal-burning equipment.

Coal was chosen when estimates pointed up its low cost compared to other available fuels. And, for full use of coal's inherent energy content, the new power plant utilizes the latest in coal-handling and combustion equipment. Burning coal the modern way continues to pay off in steam generating efficiency and substantial fuel savings for International Paper.

### Coal is lowest cost fuel

Today, *when the annual cost of fuel often equals the original cost of the boilers,* you should know that bituminous coal is the lowest cost fuel in most industrial areas. And modern coal-burning equipment gives you 15% to 50% more steam per dollar, while automatic operation trims labor costs and eliminates smoke problems. What's more, tremendous coal reserves and mechanized mining procedures assure you a constantly plentiful supply of coal at stable prices.

### Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you with the efficiency and economy of coal.

### Technical advisory service

To help you with fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to address below or send coupon. Ask also for case histories booklet, complete with data sheets. You'll find them informative.

**BITUMINOUS COAL INSTITUTE**

Department P-04, Southern Building, Washington 5, D. C.

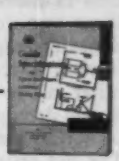
*See our listing in Sweet's Files: A-30J/Bi; PE-4a/Bi; IC-18b/Bi*

Hagan Boiler and Fuel Control panel regulates two 450,000 lb/hr Babcock & Wilcox boilers for complete, automatic control of steam generation. Generators and steam distribution are also controlled here. Feedwater control, Bailey Meter Co.

# for economy!

View from roof of power plant showing river barge delivering coal. Harnischfeger Crane unloads barges into hopper which feeds crusher. From here, Jeffrey Conveyor on right moves coal into inside bunkers, then into 650-ton Neff & Fry silo.

**SEND COUPON FOR NEW BCI PUBLICATIONS**
**Guide Specifications, with complete equipment criteria and boiler room plans:**



Bituminous Coal Institute, Southern Building, Washington 5, D. C.
Gentlemen: Please send me:

- ☐ GS-1 (low-pressure heating plant, screw-type underfeed stoker);
- ☐ GS-2 (high-pressure heating and/or process plant, ram-type underfeed stoker);
- ☐ GS-3 (automatic package boiler for heating and process plants);
- ☐ Case histories on larger plants.

P-04

Name_____

Title_____

Company_____

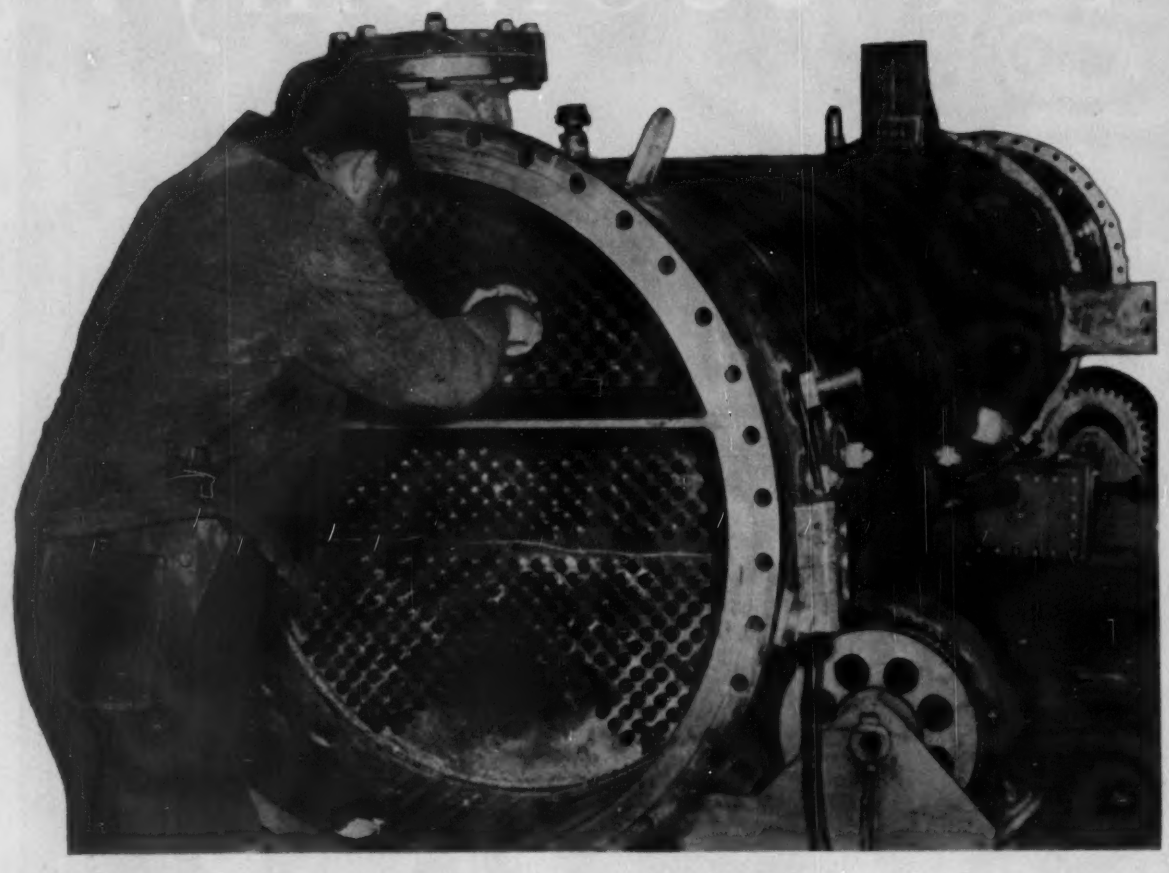
Address_____

City_____ Zone____ State_____



For more facts circle 218 on Reader Service card, p 133

# Waste heat turns into $40,000 saving thru *Carpenter* Stainless Tubing



Reclaiming valuable heat from spent black liquor vapors is a real money-saving operation with this 2600 sq. ft. 3-pass surface condenser. In the process of condensing distillation products out of a heat vapor line from a multiple-effect evaporator, the unit extracts over 19 million Btu's per hour from these vaporous products and entrained non-condensable sulphides. With this recovered heat, clean filtered water used for washing bleached pulp and other plant operations is pre-heated 25 to 30°F. Steam demand on the mill's boilers for water heating is thereby greatly reduced and fuel consumption cut. The net result of this heat recovery operation is a saving of approximately $40,000 yearly.

Contributing importantly to the success and economy of this recovery unit is Carpenter Type 304 Stainless Heat Exchanger Quality Tubing. High operating efficiency is sustained, downtime and maintenance are minimized, loss of capacity due to scale formation is avoided and long tube life is assured. Close uniform tolerance of the tubing saves installation time and costs. As a result, the use of this stainless tubing has become standard practice in these surface type condensers for black liquor evaporator service.

Now you can get cost-saving Carpenter Stainless Heat Exchanger Quality Tubing from our large mill stocks. Types 304 and 316 are available in all popular sizes and gauges. Contact our nearest office for prompt, helpful service on your next order. Send for our up-to-date Selecting and Buying Guide, Bulletin T.D. 120. The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

*your master key to cost savings in pulp mills*

**Stainless Tubing & Pipe**



For more facts circle 219 on Reader Service card, p 133

For more facts circle 220 on Reader Service card, p 133 ▶

General Electric turbine design engineers: R. Sheppard, J. E. Downs and E. H. Miller

**NOW BEING BUILT FOR NORTHERN INDIANA PUBLIC SERVICE COMPANY**

# First Pre-Engineered Tandem-Compound, Double-Flow, Reheat Steam Turbine, With New 29-Inch Last-Stage Buckets

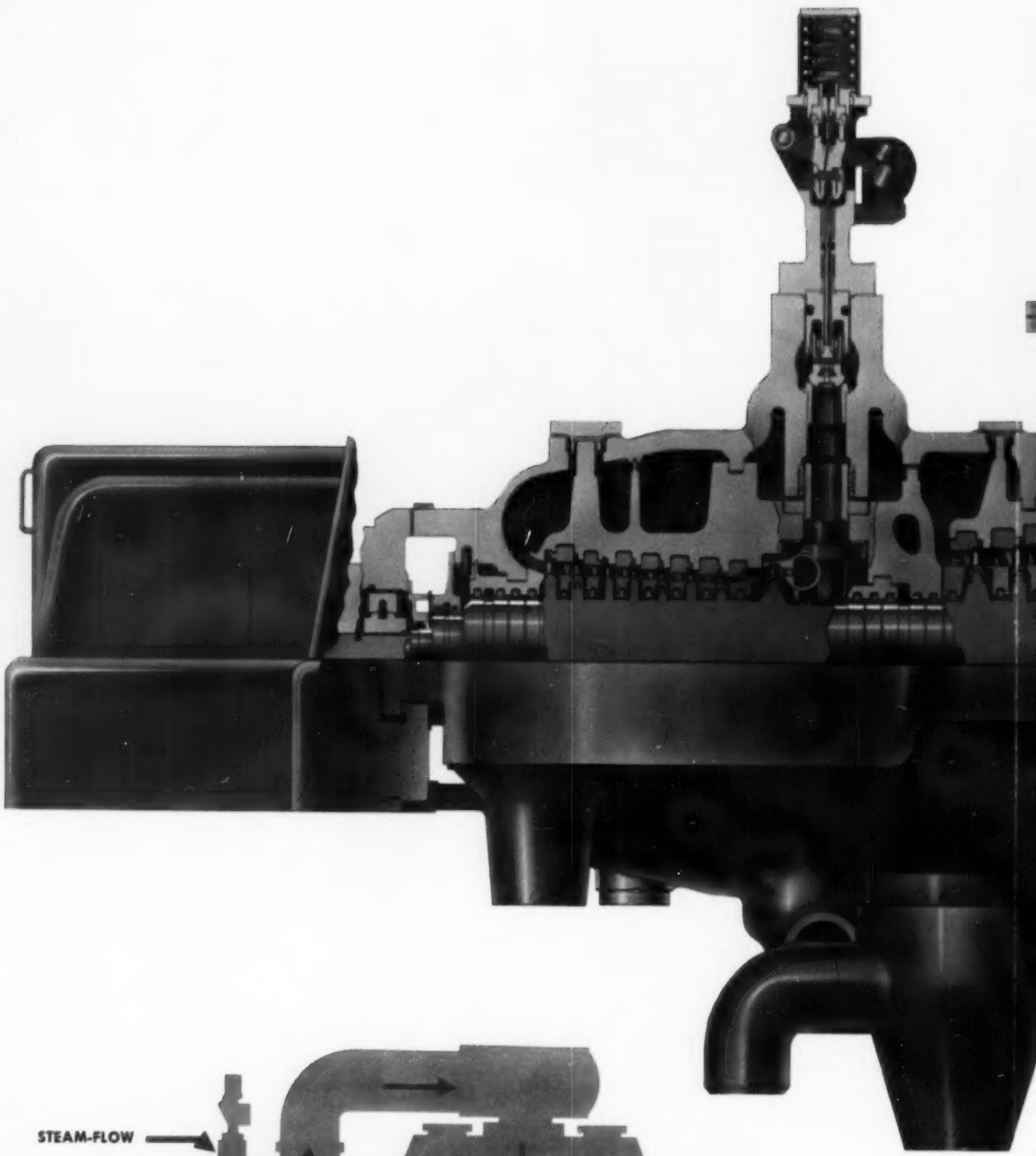
General Electric's new 29-inch, last-stage bucket now makes it practical to advance the design of the well-established 3600-rpm, tandem-compound, double-flow, reheat steam turbine to the 175,000-225,000-kw range. The first application of this pre-engineered turbine is now being built for the Baileytown Generating Station*, Northern Indiana Public Service Company.

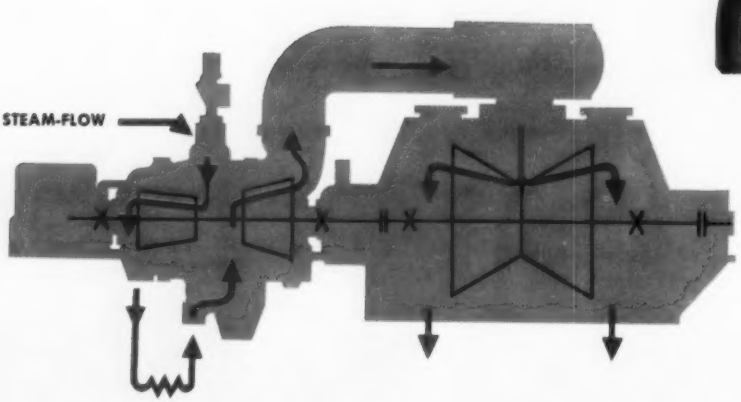
This new bucket design helps improve turbine heat rate and increases power without increasing turbine size or complexity. Inherent G-E bucket standards – high efficiency, low-vibration characteristics, long-life qualities are maintained. Further characteristics of this advance are:

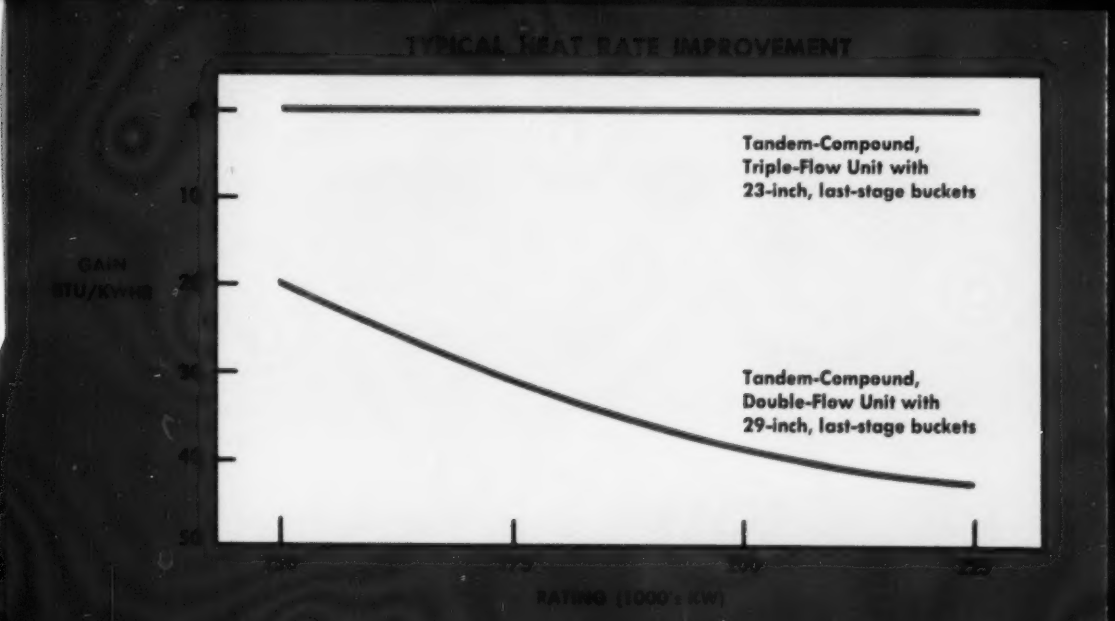
- increased annulus area over the previously longest 3600-rpm, last-stage bucket;
- efficient aerodynamic profile;
- rugged, nested pin-and-finger dovetail construction; and
- improved bucket material.

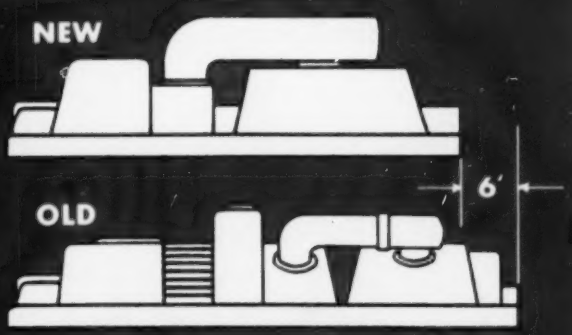
*Station designed by: Sargent & Lundy Engineers*

GENERAL ELECTRIC




STEAM-FLOW




MORE POWER,
LESS SPACE,
IMPROVED ECONOMY

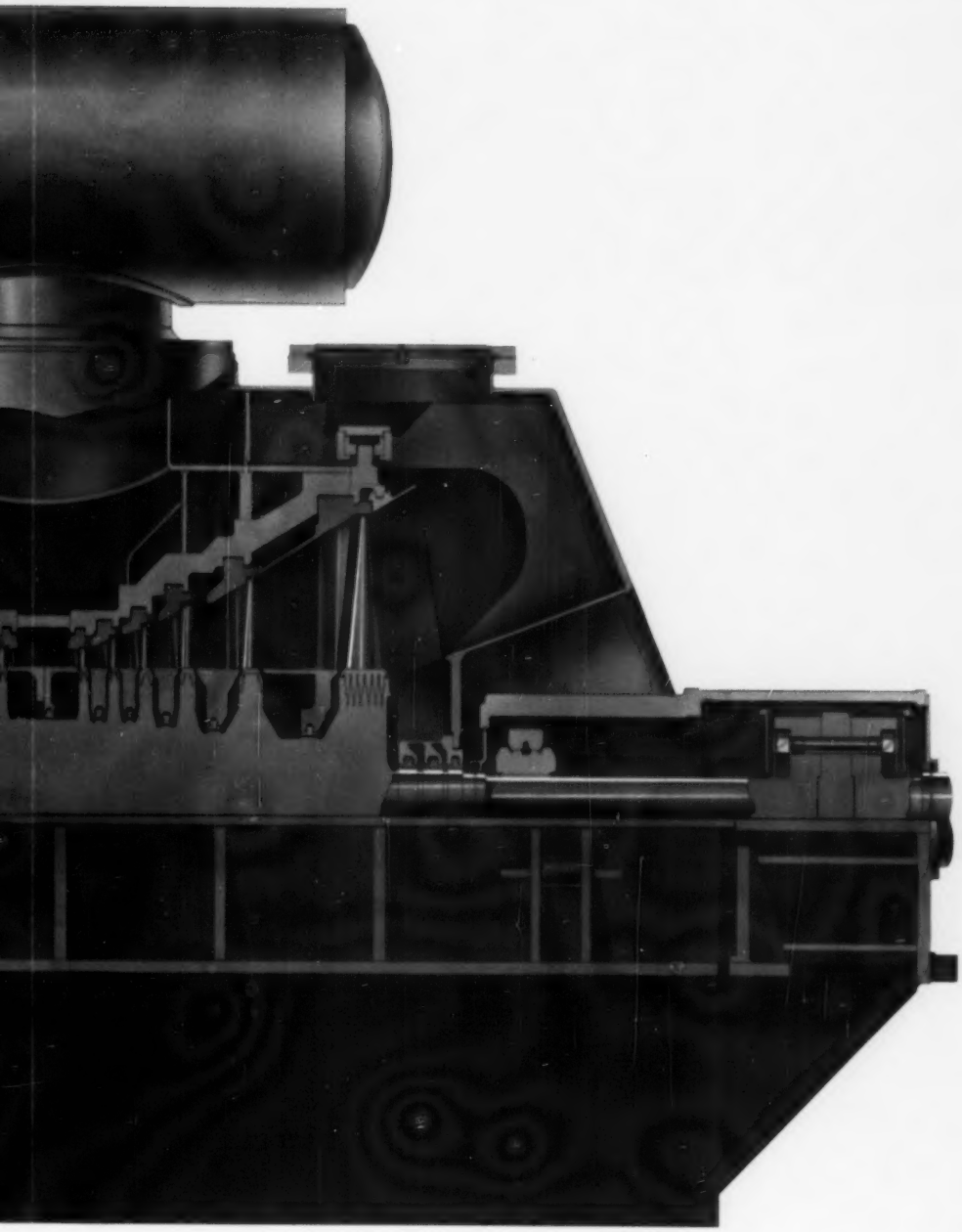
# Simplified Design Helps Improve Turbine Economy for the '60's

Inherent simplicity and ruggedness of construction have helped establish the basic double-flow design as a standard concept. Now General Electric's newly designed 3600-rpm, tandem-compound, double-flow, reheat steam turbine, with 29-inch, last-stage buckets – in addition to being more compact with improved heat rate – is adding emphasis to:

- **Smoother operation**—two bearings per rotor span allowing independent balancing, vibration isolation between spans, and shorter front standard;
- **Reliability**—intercept valves close to reheat inlets for controlled overspeed, thrust bearing in middle bearing housing for better balance of bucket-to-nozzle clearances;
- **Accessibility**—one-piece lower and upper half-shell construction, single crossover;
- **Ease of assembly and disassembly**—one less turbine rotor, one less cast steel shell, fewer bearings, packings, and couplings.

This is another of General Electric's pre-engineered turbines for the '60's – turbines which can help you meet ever-increasing power demands. For more information on any of General Electric's large steam turbine-generators, contact your nearest General Electric Apparatus Sales Office. 254-87

GENERAL ELECTRIC

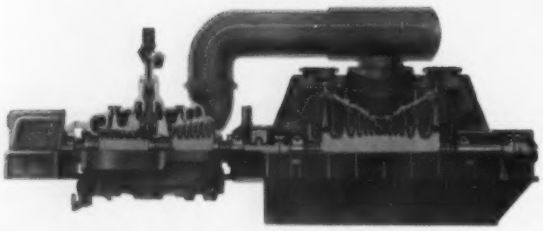


3600-rpm, tandem-compound,
double-flow, reheat steam turbine

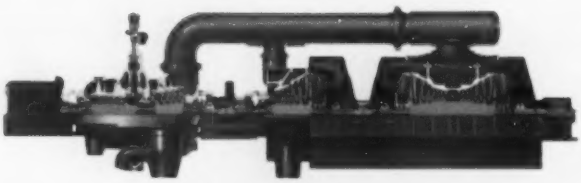
GENERAL ELECTRIC

# General Electric Pre-Engineered Steam Turbines

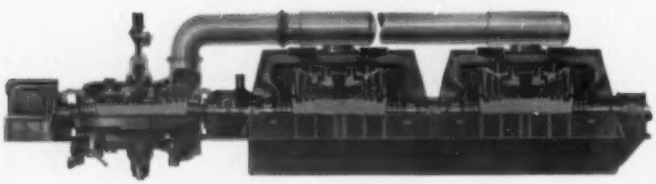
**THAT CAN BE ADAPTED TO YOUR SPECIFIC LOAD REQUIREMENTS**



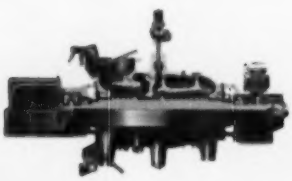
3600-rpm, tandem-compound, double-flow, reheat steam turbine

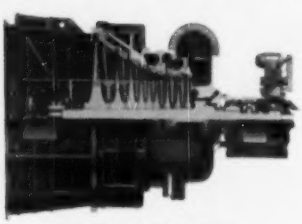


3600-rpm, tandem-compound, triple-flow, reheat steam turbine

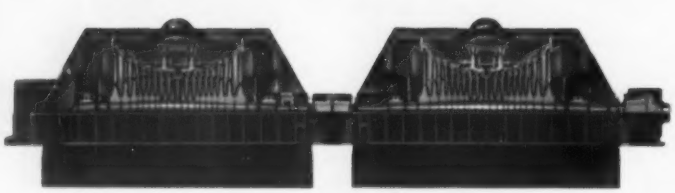


3600-rpm, tandem-compound, four-flow, reheat steam turbine

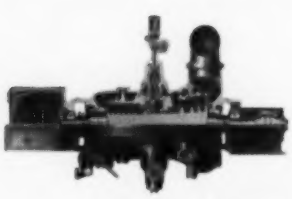


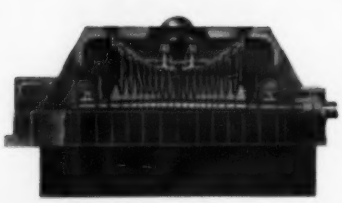


3600/1800-rpm, cross-compound, single-flow, reheat steam turbine



3600/1800-rpm, cross-compound, four-flow, reheat steam turbine





3600/1800-rpm, cross-compound, double-flow, reheat steam turbine

*Progress Is Our Most Important Product*

GENERAL ELECTRIC

*the* **WALWORTH CUSTOMER**

*looks for specialized durability in*

**BRONZE, IRON, STEEL, LPV, PLASTIC** *and*

**PRESSURE-SEAL VALVES**

*. . . and here's how he gets it*

When the Walworth Customer selects valves for special needs in fluid flow control, he insists on knowing that each type will do its job for a long time, with minimum maintenance. In Walworth Bronze Valves, for example, he finds generous wall thickness, and extra-large stems with extra-deep threads.

In Iron Body Gate Valves, the Walworth Customer checks fully open valves for the free flow of fluids. He finds streamlined ports in the Walworth Cast Steel Gate Valves to fight turbulence and pressure drop.

Tight and fast closures are on his mind when he decides on an LPV, and he finds 100% tight closure in the Walworth Lubricated Plug Valve. It is lubricant-sealed against leakage, opens or closes with a quarter turn, and can be serviced under pressure.

To control corrosive fluids the Walworth customer investigates plastic valves and in Walworth PVC Valves and Fittings he finds his answer. For PVC *cannot* corrode. Problems in extreme pressure and temperature lead the Walworth Customer to Pressure Seal valves. He learns that in the Walworth Pressure Seal Cast Steel Valves all pressure containing castings are radiographed to assure their complete soundness.

In his persistent quest for hard facts about materials, workmanship and high quality in the special valves he buys, the Walworth Customer gets his decisive answers in products bearing the Walworth name. If you, too, insist on verifying solid quality for yourself whenever you buy valves, we want you, too, for a Walworth Customer. For the newest literature on any type of Walworth Valves get in touch with your Walworth Distributor.

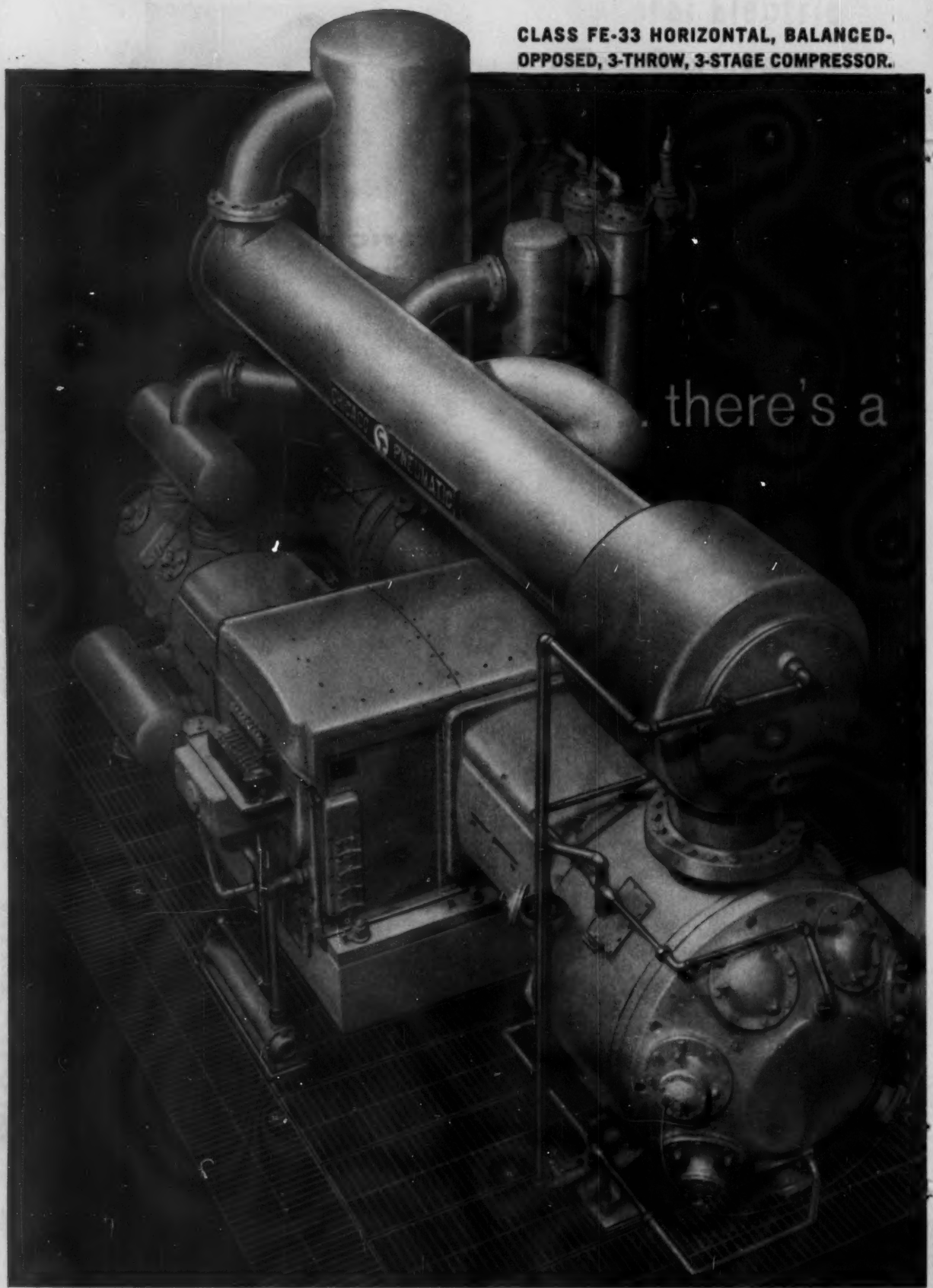
*Or write* **WALWORTH** *750 Third Avenue, New York 17, N. Y.*

DISTRIBUTORS IN PRINCIPAL CENTERS THOUGHOUT THE WORLD

*WALWORTH SUBSIDIARIES:* ALLOY STEEL PRODUCTS CO. • CONOFLOW CORPORATION • GROVE VALVE AND REGULATOR CO. M&H VALVE & FITTINGS CO. • SOUTHWEST FABRICATING & WELDING CO., INC. • WALWORTH COMPANY OF CANADA, LTD.



For more facts circle 221 on Reader Service card, p 133




CLASS FE-33 HORIZONTAL, BALANCED-OPPOSED, 3-THROW, 3-STAGE COMPRESSOR.

# whatever your process requirements

# CP COMPRESSOR

## exactly right for your needs

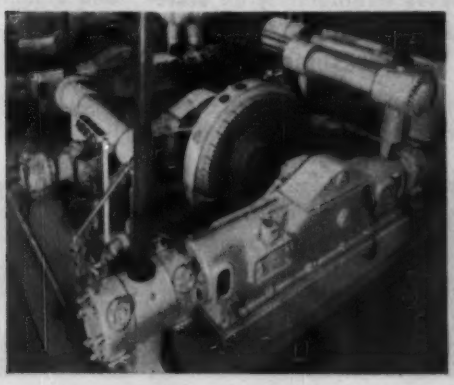
**The Class FE horizontal, balanced-opposed compressor is built in a wide range of combinations of crankthrows, cylinder arrangements and stages for pressures up to 15,000 psig; sizes up to 5,000 hp. One such combination is shown at the left.**

**Other CP Compressors from 7½ hp belt-driven vertical single-acting to 2,000 hp horizontal double-acting with belt, steam or direct motor drive.**

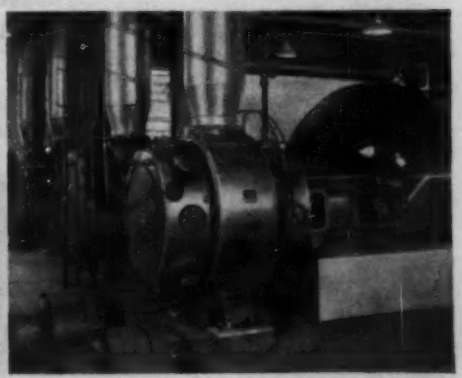
**Chicago Pneumatic** *8 East 44th Street, New York 17, N. Y.*

Air and Gas Compressors • Vacuum Pumps • Pneumatic Tools • Electric Tools • Diesel Engines • Rock Drills • Hydraulic Tools

**Class H,** horizontal duplex four-corner, 4-stage.



**Class 0-DE,** horizontal duplex, double-acting single-stage.





For more facts circle 222 on Reader Service card, p 133

SARCO

# NOW... MATCH STEAM TRAPS

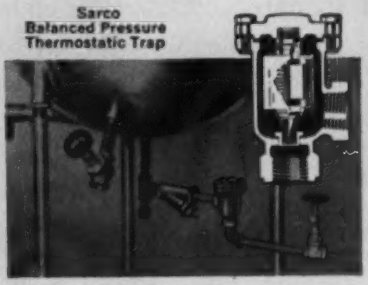
THERE'S no such thing as an all-purpose steam trap. That's why it pays to know what each trap has to offer. Here are five examples that demonstrate how you can match the correct steam trap type to the exact requirements of *each* application.

Sarco Thermo-Dynamic® Trap Type TD-50

## EXAMPLE 1: Outside Tracer Lines: A tough set of requirements

One of the most demanding sets of requirements a steam trap has to face is found in *outside steam tracing*. The trap must not only rid tracer lines of condensate and air immediately they're formed, but it must do so under exacting conditions. Pressures on each trap may vary widely. Installations may be remote and inaccessible to service. Water hammer may be a constant threat; freezing may be a hazard. Only the unique Thermo-Dynamic trap takes all these demands in stride. The Sarco TD-50 operates perfectly *without adjustment* through its full pressure range of 10-600 psi. It's virtually immune to water hammer and won't freeze when installed with a free discharge. Maintenance is, therefore, negligible. Compact, requiring no external support, the TD-50 is just about the easiest trap in the world to install. Once it's installed, you can forget it. You can count on an extremely long, trouble-free service life with minimum maintenance attention.

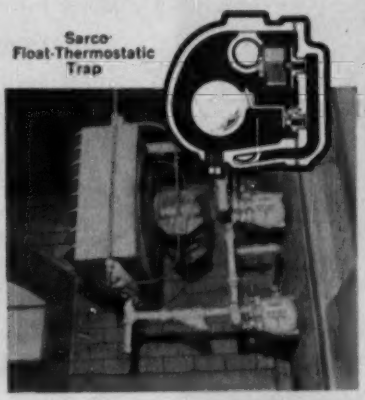
More closely than any other model, the TD-50 approximates an all-purpose trap. However, special application requirements might dictate the use of another type of Sarco trap. Sarco engineers stand ready to help you solve any trapping problems.



Sarco Balanced Pressure Thermostatic Trap

## EXAMPLE 2: For steam jacketed process kettles: a trap that operates immediately on start-up and self adjusts to both low and high pressures

When a large steam-jacketed process kettle starts up, the condensate load is high, and all air in the jacket must be released quickly. At this stage, however, the jacket pressure is low; yet it builds up rapidly as the process continues. Because a SARCO No. 9 Balanced Pressure Thermostatic Trap is wide open on start-up, it releases initial air and condensate without the need for a bypass. And because it is self-adjusting, it works just as efficiently during the first processing stage when the jacket pressure is high. There are no seats to change for various working pressures. You can see why it is the obvious choice for steam jacketed process kettles.



Sarco Float-Thermostatic Trap

## EXAMPLE 3: How to prevent water-logging in unit heaters and blast coils

All unit heaters and blast coils have a relatively small internal volume in comparison with their steam condensing capacity. Even slight water-logging can reduce heat output seri-

Impartial advice on trapping because
ONLY SARCO MAKES ALL 5 STEAM TRAP TYPES

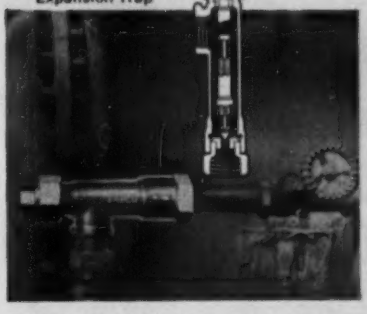
# TOPICS

SARCO

# TO YOUR TRAPPING NEEDS

ously. Pressures may vary widely under automatic temperature control and so may the load because of variable demand. A trap to handle this application must adjust itself instantly to pressure and load charges. The most precise answer to this problem is the SARCO Float and Thermostatic Trap—and here's why: it releases air on start-up and during running, and, because it discharges condensate continuously, it does not set up in the system violent pressure changes that would upset close control.

Sarco Liquid Expansion Trap



## EXAMPLE 4: How to release low temperature condensate

When condensate cannot be returned to the boiler feed tank either because of distance or because it may be contaminated, it's economical to utilize some of the sensible heat as well as the latent heat of the steam.

For this purpose a trap must be capable of releasing condensate to temperatures as low as 100° F.

The sound trap selection here is the SARCO No. 871 Liquid Expansion Trap because it can be set to release condensate at temperatures down to 100° F. regardless of supply pressure. This performance assures maximum steam economy. The Sarco No. 871 handles the starting load easily because of its wide open valve, which throttles the flow as the condensate temperature rises. Furthermore waterhammer cannot reach the operating element. No other type is as nearly perfect for this specific problem.

Sarco Bucket Trap

## EXAMPLE 5: Economic handling of Water Hammer and Corrosive Conditions

In applications in which water hammer or corrosive conditions are encountered but in which low pressures or extremely high back pressures preclude the use of the Thermo-Dynamic trap, the Sarco Inverted Bucket Trap is recommended. While the Sarco I. B. is not exactly a fuel miser, its relatively rugged construction will withstand considerable water hammer; and, when it is fitted with stainless steel internal parts, it offers excellent resistance to corrosion.

* * *

## CONCLUSION: The right application is the economical installation

When you choose steam traps that serve their purpose without frequent adjustment, and without maintenance or replacement problems, you save on down-time, man-hours, spare parts, and production slowdowns.

You can get the money-saving solution to every trap selection problem by consulting Sarco. You get impartial solutions, because only Sarco makes all 5 types of steam traps: Thermo-Dynamic*, Thermostatic, Float Thermostatic, Liquid Expansion, and Bucket.

You also get the benefit of Sarco's 50 years of specialized experience in the manufacture and application of temperature regulators, industrial air vents, pipeline strainers, dial and industrial thermometers, heating and cooling controls, heat exchangers, heating control systems and heating specialties.

For literature or impartial help in solving your steam trapping or control problems, contact your local Sarco Sales Representative, or write direct to Sarco. 1440

*U.S. Pat. No. 2,817,353. T.M. Reg. U.S. Pat. Off.

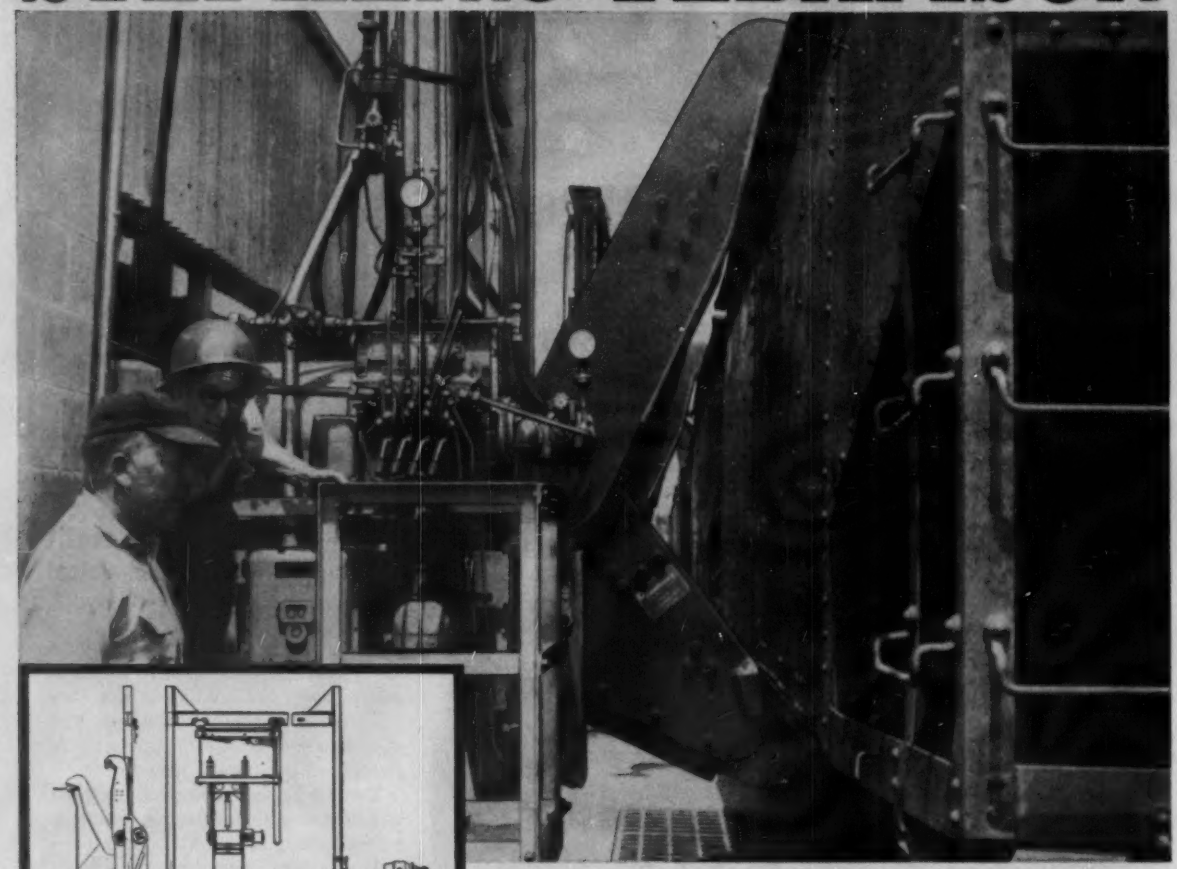
SARCO COMPANY, INC.

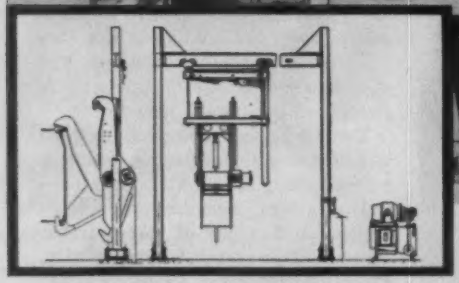
635 Madison Avenue
New York 22, N. Y.
Plant: Bethlehem, Pa.



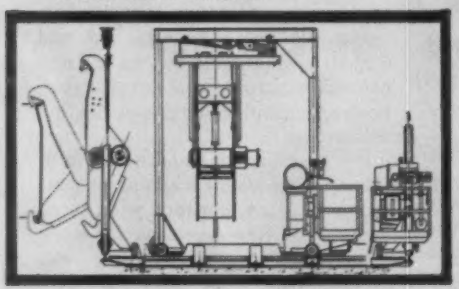
For more facts circle 223 on Reader Service card, p 133

# STEPHENS-ADAMSON





**TYPE "B" STATIONARY MOUNTED CARQUAKE**
Designed for applications where only slight movement parallel to hopper cars and tracks is required. The unit is mounted to the customer's concrete hopper foundation or steel structure with anchor bolts.



**TYPE "C" RAIL MOUNTED CARQUAKE**
Mounted on rails permitting travel any desired distance and unloading into any hopper. Concrete piers or steel structure for anchoring rails are all customer need furnish.

## NOW! MINIMUM NOISE WITH MAXIMUM EFFICIENCY IN UNLOADING HOPPER CARS

HYDRAULICALLY POWERED

## SA CARQUAKE

- One man unloads hopper-bottom railroad cars quickly, efficiently and with less noise than overhead car shakeouts.
- Hydraulically powered vibration with speed controlled to match required capacity.
- No expensive overhead structures needed — a completely self-contained unit—unlimited movement parallel to track.
- Avoids demurrage charges — saves manpower — speeds unloading operations.

WRITE FOR BULLETIN 658

S-A

**ENGINEERING DIVISION**
**STEPHENS-ADAMSON MFG. CO.**
GENERAL OFFICE & MAIN PLANT, 5 RIDGEWAY AVENUE, AURORA, ILLINOIS
PLANTS LOCATED IN: LOS ANGELES, CALIFORNIA • CLARKSDALE, MISSISSIPPI
BELLEVILLE, ONTARIO



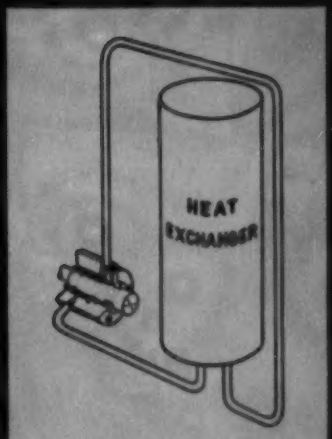
For more facts circle 224 on Reader Service card, p 133

# THE ANCHOR PACKING COMPANY

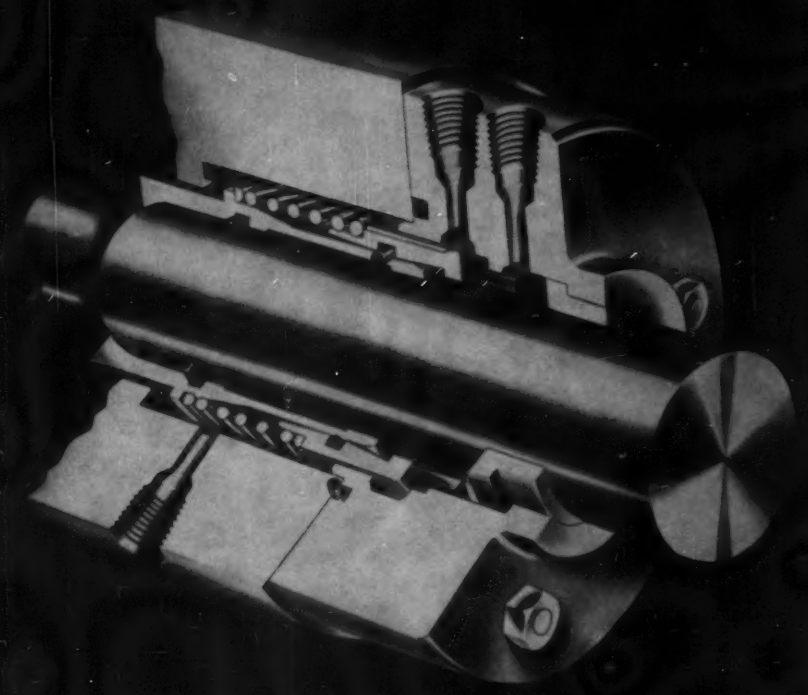
presents

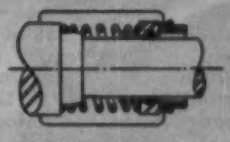
**SEALOL flexibox**

# BOILER FEED PUMP SEALS




Seal acts as pump forcing feedwater through heat exchanger and back to seal.





**PATENTED SPRING DRIVE**

This exclusive feature insures uniform and dependable torque transmission. At the same time, it compensates for shaft misalignment, thermal expansion and vibration.

Pat. Nos. [illegible]

Cut boiler feed pump operating costs with these high-performance, mechanical seals. Simple auxiliary cooling provides the proper seal environment necessary for years of trouble-free service, prevents feedwater contamination.

Your inquiries for specific installations are solicited.

**DISTRICT OFFICES**

| | | | |
|---|---|---|---|
| BALTIMORE, MD. | DAYTON, OHIO | MINNEAPOLIS, MINN. | SAN FRANCISCO, CAL. |
| BOSTON, MASS. | DETROIT, MICH. | MONTREAL, CANADA | SEATTLE, WASH. |
| BUFFALO, N.Y. | HOUSTON, TEX. | NEW ORLEANS, LA. | SPOKANE, WASH. |
| CHICAGO, ILL. | INDIANAPOLIS, IND. | NEW YORK, N.Y. | ST. LOUIS, MO. |
| CINCINNATI, OHIO | LOS ANGELES, CAL. | PHILADELPHIA, PA. | TOLEDO, OHIO |
| CLEVELAND, OHIO | MILWAUKEE, WIS. | PITTSBURGH, PA. | WILMINGTON, CAL. |

## THE ANCHOR PACKING COMPANY

GENERAL OFFICES . . . PHILADELPHIA, PENNSYLVANIA
FACTORIES . . . MANHEIM, PA., ELKHART, IND., MONTREAL, CAN.

FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

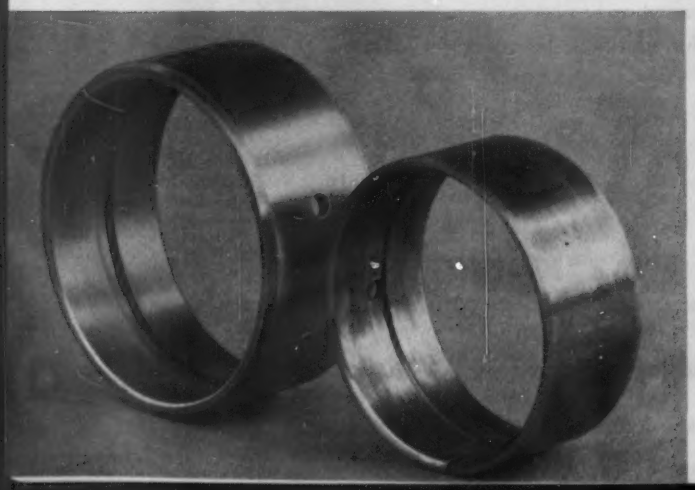


For more facts circle 225 on Reader Service card, p 133

# Onan Electric Plants are when this independent

**Big, beefy bearings for longer life.** (Lower left) double-size Onan bearings vs. small bearings (right) used in many other makes. Larger bearing surface reduces wear, stretches time between overhauls. Onan builds up to performance—never down-to-a-price.

**The engine that ran equivalent to 487,888 automobile miles.** Here's endurance no auto could begin to match. Onan engine #1068 was operated for 12,197 hours. It was stop-started 100 times. At test's end #1068 and generator were delivering their stated output.



# Performance Certified only tester says O.K.

## *His job is to provide a double-check on Onan's own tests and testing methods*

The man at the left is an expert from an independent testing laboratory. On the job, he believes nothing except what his trained eyes, ears and scientific testing instruments tell him.

He, and others like him, pay frequent surprise visits to Onan factories. He can pull any Onan plant off the test line. Put it through its paces. Recheck the checks Onan engineers and inspectors have already made. He has authority to pull a whole series of plants off the line if he finds one fault. He does all this even though every Onan plant is tested for hours by Onan personnel *before it is shipped.*

Onan takes these special precautions to make *doubly* sure that you get all that you pay for, and more, when you own a Performance Certified Onan. For more details—and an analysis of your primary and stand-by power needs—see the Onan distributor nearest you. He's listed in the telephone classified section in all major cities. Or write direct.

**ONLY ONAN GIVES YOU THIS GUARANTEE**

PERFORMANCE CERTIFIED
We guarantee that when properly installed and operated this Onan electric plant will deliver the full power and the voltage and frequency regulation promised by its nameplate and published specifications. This plant has undergone several hours of running-in and testing under realistic load conditions, in accordance with procedures certified by an independent testing laboratory.
D. W. ONAN & SONS INC.
Minneapolis 14, Minnesota
Onan

Onan®

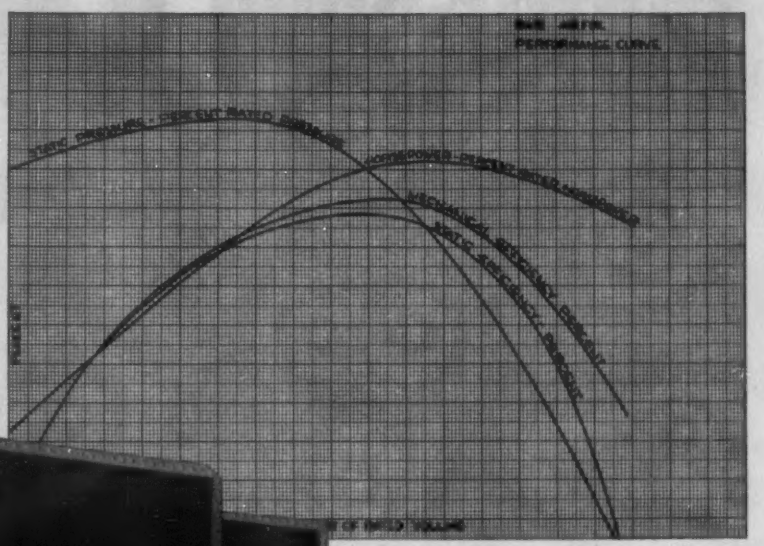
*World's Leading Builder of Electric Power Plants*

**D. W. ONAN & SONS INC., 2536 UNIVERSITY AVE. S.E., MINNEAPOLIS 14, MINN.**

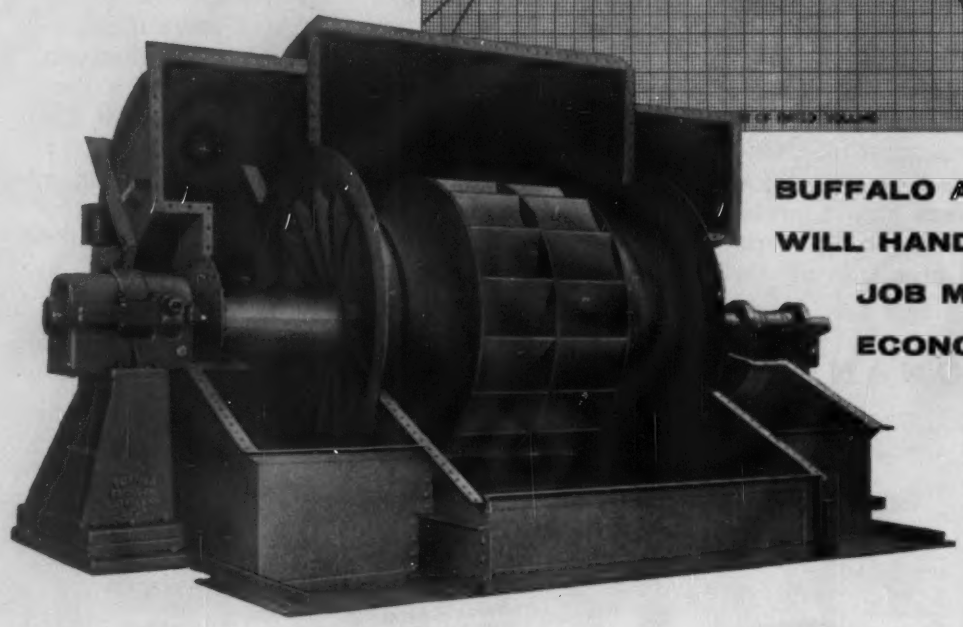


For more facts circle 226 on Reader Service card, p 133

# PLAN TO OPERATE AT FULL RATED CAPACITY OVER EXTENDED PERIODS?



*Performance curve of a Buffalo type "BA" Airfoil Fan shows how static efficiency curve peaks in the designed operating range of the capacity—pressure curve.*



**BUFFALO AIRFOILS WILL HANDLE THE JOB MOST ECONOMICALLY**

Extreme high efficiency between 85 and 110% of rated volume — top performance against high static pressures — make the Buffalo Type "BA" Airfoil your best selection for continuous, full-capacity draft service. Its streamlined inlet bell and matching wheel flange form a smooth, path for easiest air flow into the wheel. Its aerodynamically formed airfoil blade channels provide optimum air passage thru the wheel; while the unique design diverging outlet permits best static regain from cutoff.

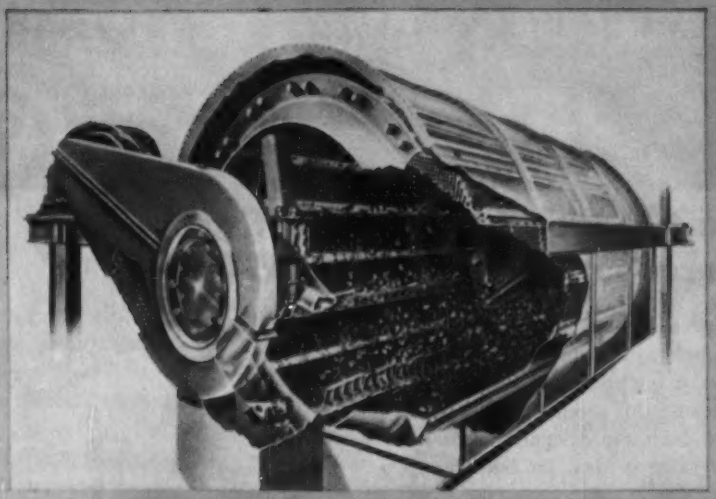
And the Type "BA" Airfoil is one of a full line of Mechanical Draft Fans to fit today's widely varying requirements — each built to the famous "Q" Factor* of excellence. For full details on the best draft fan for your money and your job, write for Bulletin FD-905.

**The "Q" Factor—the built-in Quality which provides trouble-free satisfaction and long life.*

**BUFFALO FORGE COMPANY**
Buffalo, New York
*Buffalo Pumps Division • Buffalo, N. Y.*
*Canadian Blower & Forge Co., Ltd., Kitchener, Ont.*

VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT • EXHAUSTING • FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING


For more facts circle 227 on Reader Service card, p 133



Pennsylvania Bradford crushes, sizes, scavenges all in one operation—at lowest cost

# PENNSYLVANIA BRADFORD BREAKERS prepare over 160 million tons of coal each year

Because no other coal processing machine does so much for so little—Pennsylvania Bradford Breakers have become a standard of the industry.

At power plants, by-product coke plants, coal mines and coal cleaning plants Pennsylvania Bradfords clean, size and scavenge at phenomenal low cost.

Data from 10 installations over 8 years shows an average maintenance cost of $.001 per ton, and an average power consumption of .204 KW per ton.

### TRIPLE ACTION

Continuously charged, the Pennsylvania Bradford immediately screens out passing sizes of coal through the screen plates. Larger lumps are raised and dropped, breaking by gravity impact until they are screened. All refuse—sulphur balls, slate, rock, tramp iron, etc.—resist breakage and travel the full length of the breaker where they are discharged.

### BRADFORD-HAMMERMILLS

For reduction of particularly hard coals and for heavier loading, Bradford-Hammermills are frequently specified. This machine combines a concentrically-mounted rotor of a hard-hitting Pennsylvania Hammermill at the rear end of the slow speed Bradford Breaker. Capacities are increased over 20%.

### FREE BULLETIN

For the full story on Pennsylvania Bradford Breakers and Bradford-Hammermills write for Bulletin 3007.

# RING-TYPE GRANULATORS

For preparing coals for stoker and pulverizer fuel, and other uses where overgrinding is undesirable, Pennsylvania Ring-type Granulators have no peer. Exclusive design; exclusive advantages. Completely described in Bulletin 9002. Send for it.

**PENNSYLVANIA CRUSHER DIVISION**
BATH IRON WORKS CORPORATION
WEST CHESTER, PENNA.

★ ★ ★

*Over 50 years concentrated experience in all types of material reduction makes Pennsylvania your best source of crushers and engineering advice and service. Call on Pennsylvania with your next crushing problem. Representatives from coast-to-coast.*

PENNSYLVANIA CRUSHERS

BATH-BUILT



For more facts circle 228 on Reader Service card, p 133

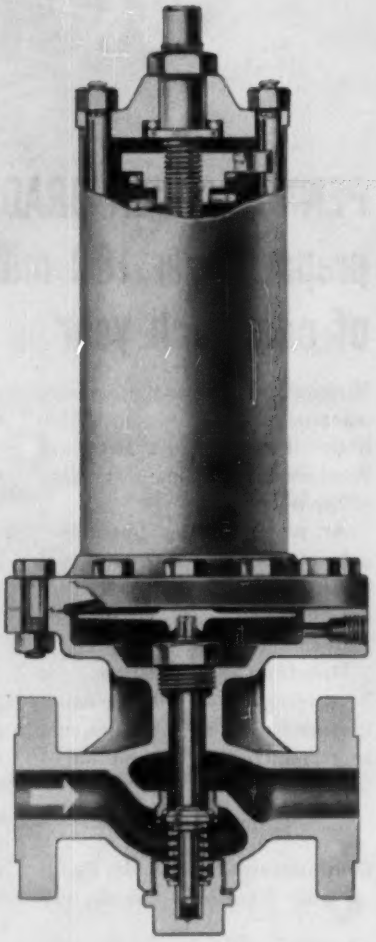
# NOW ADDED TO LESLIE's COMPLETE LINE...

# TWO NEW CONCEPTS IN

## NEW LESLIE-TOPPER® VALVE DESIGNED WITH PILOTING DEVICE ENTIRELY *OUT OF THE PATH OF STEAM*

The new Leslie Topper self-contained pressure reducing valve offers a new level of accuracy, simplicity and low-maintenance service (see chart below). Key to this revolutionary valve is a piloting device which is entirely out of the path of steam. Because this mechanical pilot is sealed-off from the steam and all valve parts are designed without dirt-catching passages, the new Topper valve is ideal for both poor steam conditions and intermittent duty.

It can handle low-reduced pressures and is used in process lines, steam heat reducing stations and for make-up steam supply to heaters, gland sealing system and process equipment. You benefit from added reliability, plus the accuracy of a pilot operated valve and the rugged simplicity of direct operation. It means less shut-down time for maintenance, surer pressure control and increased plant efficiency.



### SPECIFICATIONS

**Sizes, Body Materials and End Connection:**
*½—2", cast iron, and bronze, screwed, 150 and 300 lb. bronze, flanged.*
*1—2" 125 and 250 lb. cast iron, flanged bodies.*

**Three Spring Ranges:** *2-10 psi; 5-20 psi; 15-35 psi.*

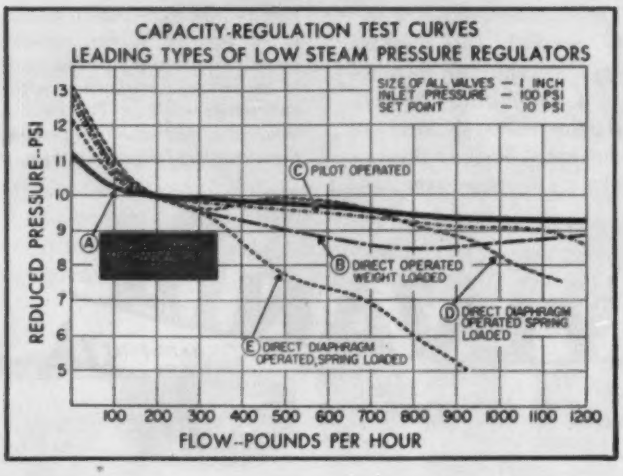
**Long-travel metal diaphragm:** *2 ply, phosphor bronze, Spiro-flex.®*

**Main Valve:** *Hardened 440C stainless steel.*

**Seat Ring:** *Stellited stainless steel.*

**Stem Guides:** *Gun metal bronze (top and bottom guided).*

**Main Valve Spring:** *Inconel.*




*For sizing and capacity data, contact your Leslie Engineer or write for Bulletin 582.*

LC-8

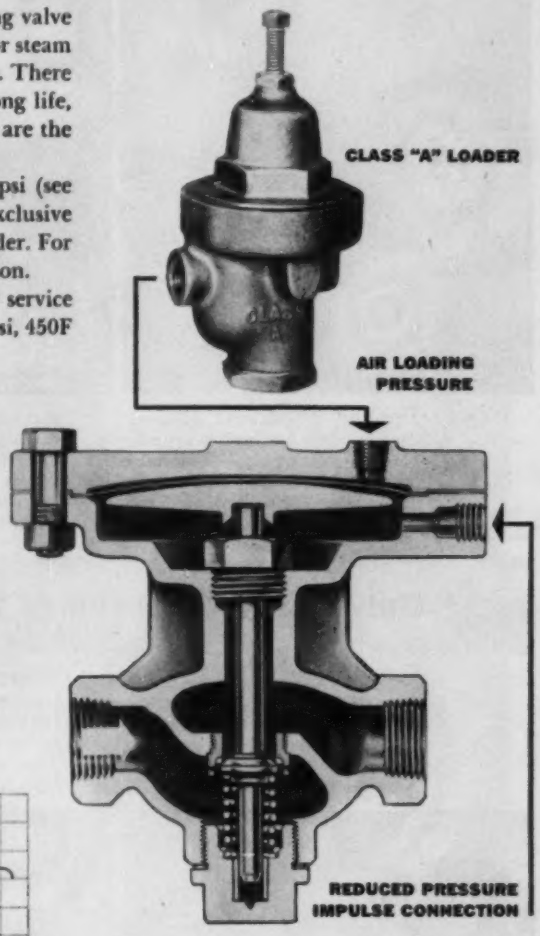
# PRESSURE REDUCING VALVES

## LESLIE AIR-LOADED REDUCING VALVE GUARANTEED MAINTENANCE-FREE FOR THREE FULL YEARS

New Leslie air-top GPK diaphragm operated, pressure reducing valve is guaranteed maintenance-free for three full years. Designed for steam heat or process steam application, it has only two moving parts. There are no seals, no stuffing boxes, no small dirt catching parts. Long life, long-travel diaphragm and hardened stainless steel main valve are the only parts that move.

You get accurate response even to flow changes as small as 0.1 psi (see chart below). This exceptional responsiveness results from exclusive diaphragm design and the accuracy of the simple Leslie air loader. For added flexibility, pressure can be adjusted from remote location.

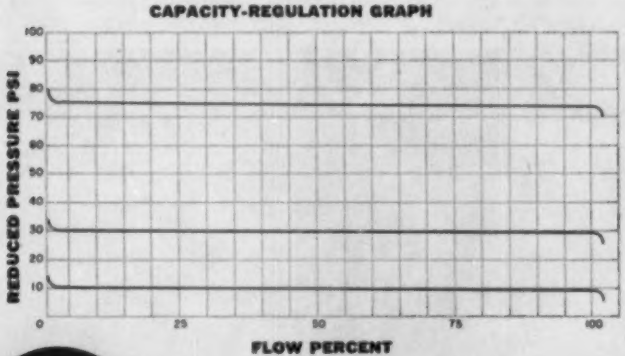
Especially desirable for poor steam conditions and standby service requirements, the GPK is suitable for steam service up to 250 psi, 450F and is available in ½" to 4" sizes.




### SPECIFICATIONS

**Sizes:** *½ to 2", cast iron or bronze, screwed ends. 2½, 3 and 4", cast iron, 125 or 250 lb. flanged.*
**Main Valve:** *Hardened 440C Stainless Steel.*
**Seat Ring:** *Stellited Stainless Steel.*
**Stem Guides:** *Gun Metal Bronze (top and bottom guided).*
**Main Valve Spring:** *Inconel.*
**Inlet Pressure Range:** *0-250 psi, 450°F.*
**Reduced Pressure Range:** *0-85 psi with Class A loader, up to 249 ½ psi with any suitable high pressure loader.*
**Minimum Pressure Drop across Valve:** *½ psi.*
**Available with manual opening device in sizes ½—1¼".**

**CAPACITY-REGULATION GRAPH**




*For sizing and capacity data, contact your Leslie Engineer or write for Bulletin 561-B.*

LESLIE TRADE MARK

**REGULATORS and CONTROLLERS**
**Leslie Co., 236 Grant Avenue, Lyndhurst, New Jersey**

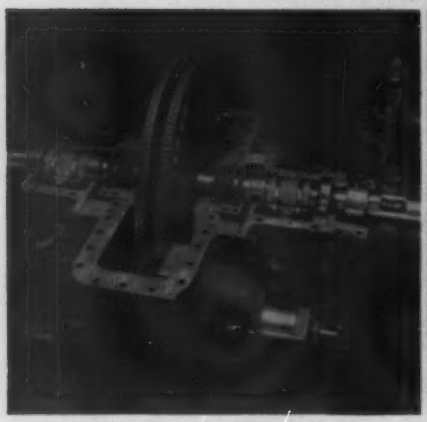
**Over 275 Factory-Trained Engineers At Your Service—Nationwide!**


For more facts circle 229 on Reader Service card, p 133

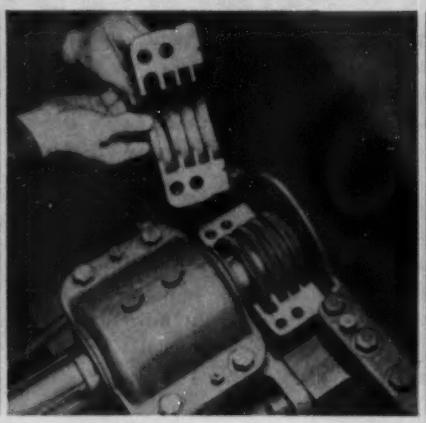
*Economical in operation...*

*Dependable always*

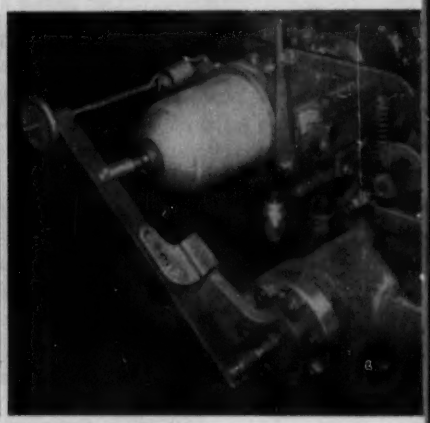
# ELLIOTT



*Precise alignment* of shaft, through true centerline support, permits smooth and dependable operation at all operating temperatures. The entire rotor assembly is dynamically balanced.



*Accessible* shaft-seals simplify maintenance and routine inspection. Shaft surface under packing glands is stainless steel. Covers are readily removable without disturbing the upper-half casing.



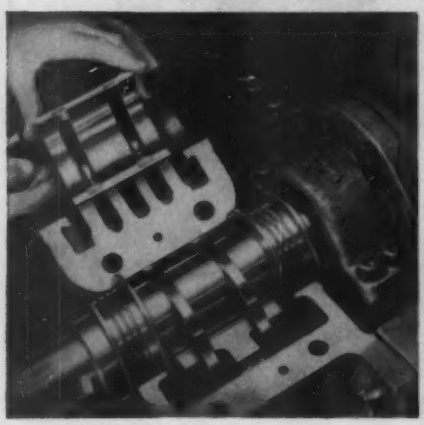
*Simple, Positive* direct-acting speed-governing system is dependable, weather-proof, accurate. Separate trip gives positive overspeed protection, and it may be easily reset against line pressure.

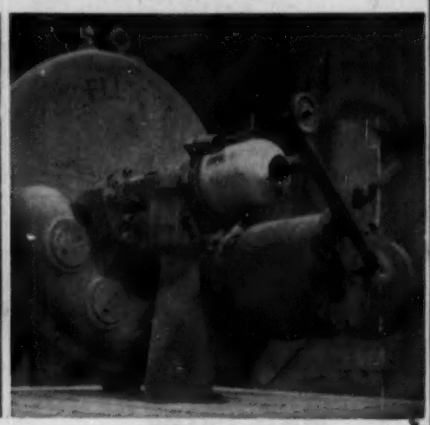
## Only ELLIOTT Turbines give you all these PLUS features

*By separating* the pedestal-mounted exhaust-end bearing from the hot turbine casing, the temperature distortion is minimized, and the vertical shaft movement is thereby eliminated.

*Steam-saving* hand valve with pilot, which can be opened against full steam pressure, reduces steam consumption at partial loads. This feature is available on all sizes of Elliott YR steam turbines.

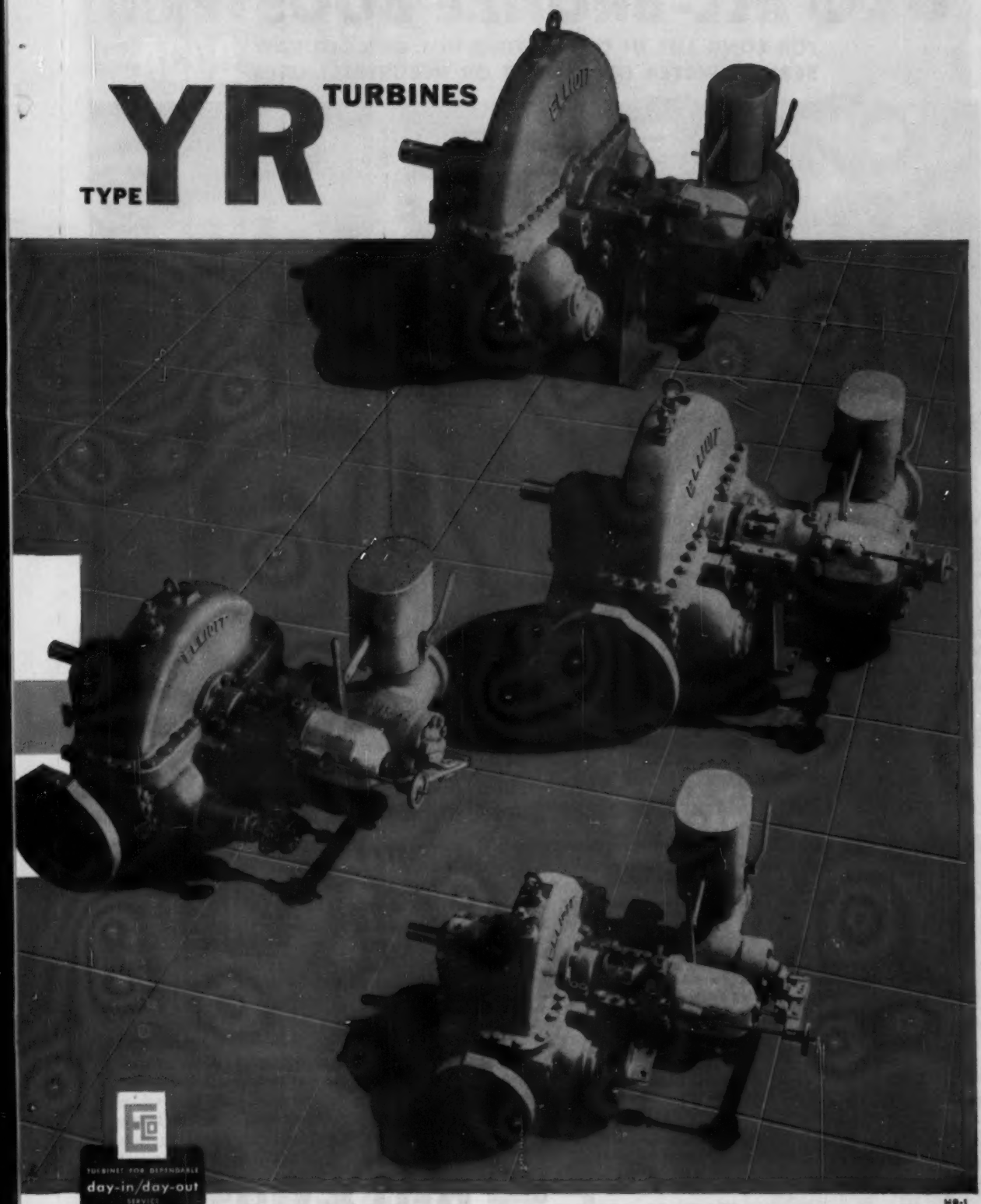
*All-weather protection* is standard for Elliott YR turbines. They shrug off heat, dirt, snow, moisture or contaminated atmosphere. Stainless steel exposed parts are furnished for extreme conditions.





In addition to the units illustrated here, Elliott makes single-stage turbines in special frames, reduction gears, multistage mechanical drive turbines to 50,000 hp, and turbine-generators ranging through 44 mw.

# TYPE YR TURBINES




TURBINES FOR DEPENDABLE
day-in/day-out
SERVICE

HB-1

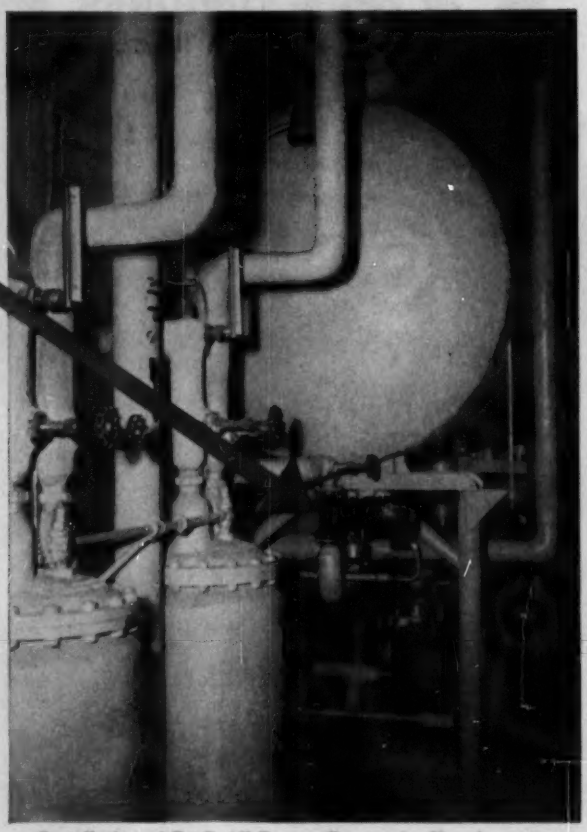
**ELLIOTT Company** JEANNETTE, PENNA.




For more facts circle 230 on Reader Service card, p 133

# B&G ALL-BRONZE BOOSTERS

## FOR LONG LIFE IN CIRCULATING HOT OR COLD RAW SERVICE WATER FOR FAUCET OR INDUSTRIAL USES

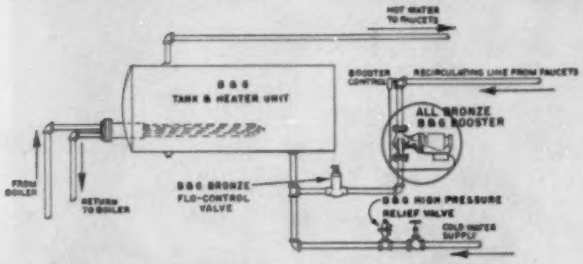


Where hot or cold service water is to be pumped, the use of an all-bronze pump is imperative. Otherwise, the corrosive effects of continuously pumping fresh water materially shortens pump life.

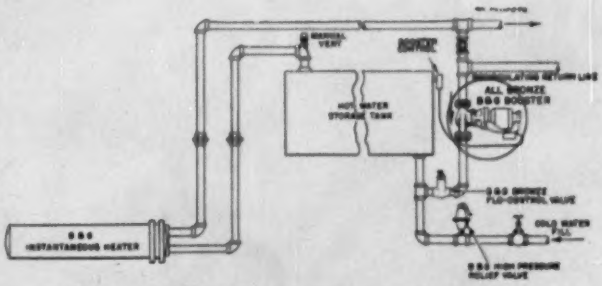
The B&G All-Bronze Booster is specifically built for service water pumping applications. In such systems, the Booster can be installed in numerous ways to step-up efficiency, increase hot water production and reduce heating costs. It is immune to corrosion, hence will give years of dependable service.

For *quiet* operation, failure-proof performance and long life, the B&G Booster is the *preferred* pump.

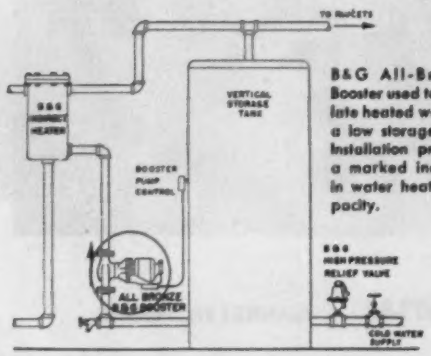
*Installation of B&G All-Bronze Booster in Chrysler automatic transmission plant at Kokomo, Indiana. This small unit handles the circulating requirements of the service water heating system.*




B&G All-Bronze Booster used on recirculating line from hot water faucets maintains hot water at fixtures at all times. Recommended on all installations, particularly where long plumbing lines are used.




All-Bronze B&G Booster used to provide an extra supply of hot water from an undersized boiler. Semi-tankless hook-up maintains initial supply of hot water.




B&G All-Bronze Booster used to circulate heated water to a low storage tank. Installation provides a marked increase in water heater capacity.

**Send for Bulletin No. IA-856**

**BELL & GOSSETT**
**COMPANY**
**Dept. GD-36, Morton Grove, Illinois**

*Canadian Licensee: S. A. Armstrong Ltd., 1400 O'Connor Drive, Toronto 16, Ontario*

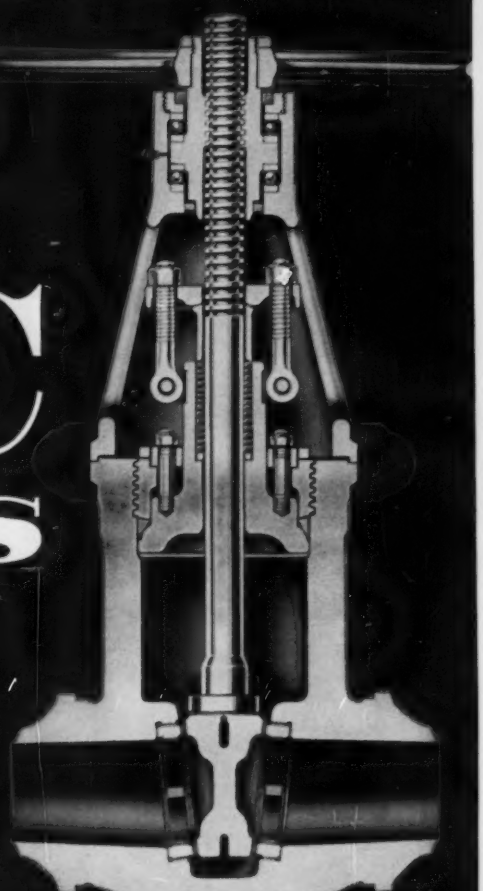


For more facts circle 231 on Reader Service card, p 133

ACCO
for Better
Values

# R-P&C VALVES

THE COMPLETE LINE
—DESIGNED FOR DEPENDABILITY



## R-P&C Pressure Sealed Valves Meet Requirements of High Pressure and High Temperature Applications

• The R-P&C Pressure Sealed Valve pictured above—made of electric furnace cast steel—has been successfully developed to meet demands for valves that provide tightness under varying conditions encountered at high pressures and high temperatures. These valves, available in gates (up to 12″) and globes (up to 8″) in 900, 1500 and 2500 pound classes, are also being used increasingly for less difficult services, because of the *inherent advantages of pressure-sealed construction.*

Among these advantages are: elimination of bonnet flanges; tightness unaffected by temperture changes; quick, easy inspection—disassembly and reassembly; reduced weight without loss of strength; savings of space; ease of insulation; neat appearance.

R-P&C Pressure Sealed Valves typify the high quality of the entire cast steel line, including gate, angle, globe, swing check and lift check styles in many sizes and pressure classes (150-2500 psi).

### A COMPLETE Line of Valves

Whenever you need valves of *any* kind, it's good business to look to R-P&C. The R-P&C Valve line includes gate, globe, angle and check valves in bronze, electric iron and cast steel, and forged steel. Also, R-P&C offers a full line of cast steel fittings, as well as specialties such as bar stock and Lubrotite gate valves, asbestos-packed cocks and other items.

• • •

Write our Reading office for catalog.

**FREE WALL CHART**
***"How to Protect Your Valves"***
Installation pointers, operating tips, clues to longer valve life. They are all on this 22″ x 17″ wall chart. Write for your free copy.

**R-P&C VALVE DIVISION**
**AMERICAN CHAIN & CABLE**

Reading, Pa., Atlanta, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

ACCO

FROM THE BOILER CAPITAL OF THE WORLD

# 100

# THE TITUSVILLE-ATLAS

What kind of a headline is 100 x 1,000 for an ad about boilers? Well, it's not a magic formula . . . it just represents a simple fact—Titusville has produced and sold more than 100,000 boilers. That's why Titusville is known as *the boiler capital of the world!*

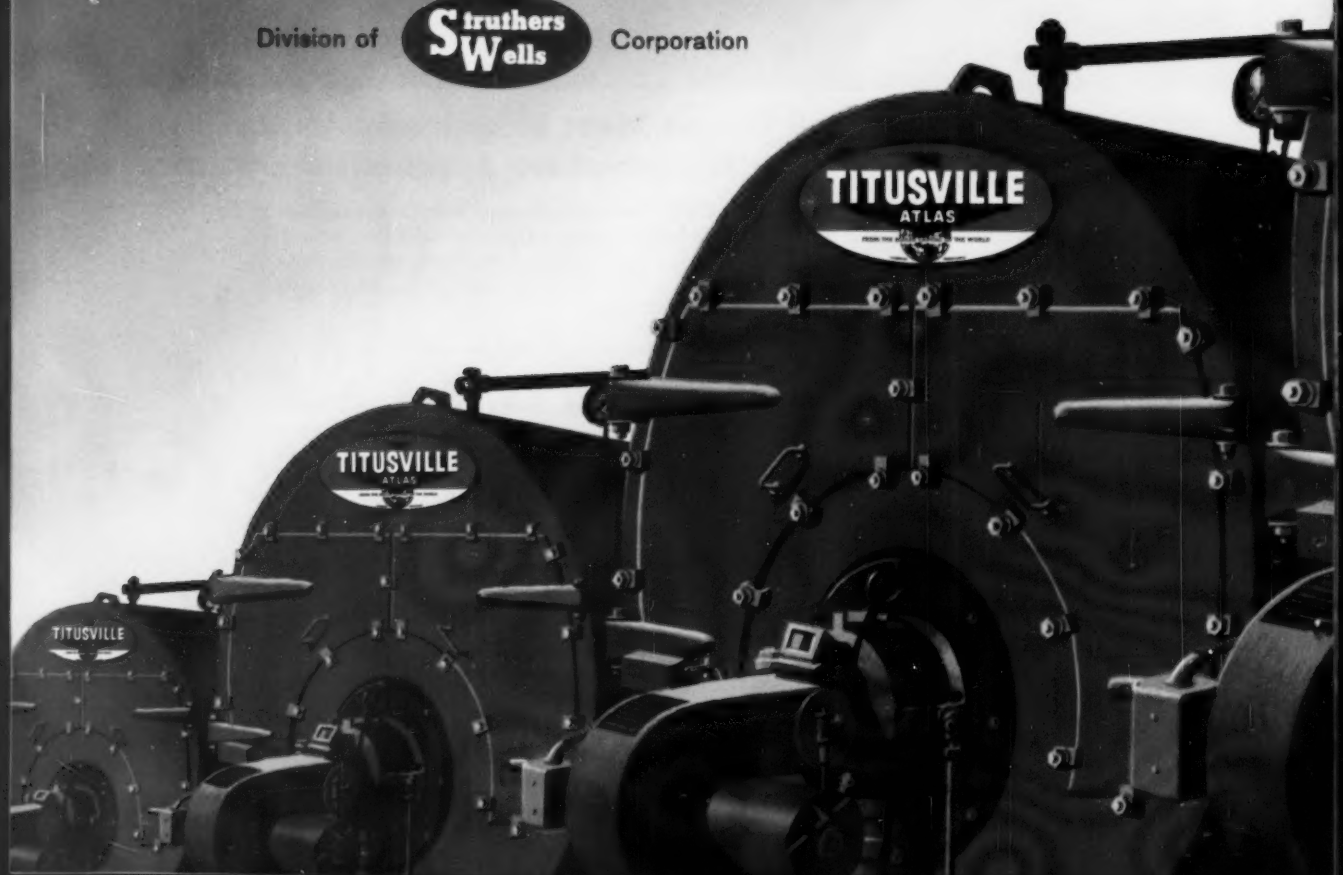
The complete TITUSVILLE-ATLAS unit, known for its BONUS POWER, is the result of the engineering know-how and experience that has gone into the production of those 100,000 boilers. TITUSVILLE-ATLAS—the only unit with a patented wet-back, assuring you of longer life . . . higher maintained efficiency . . . fewer repairs and more horsepower per total energy input.

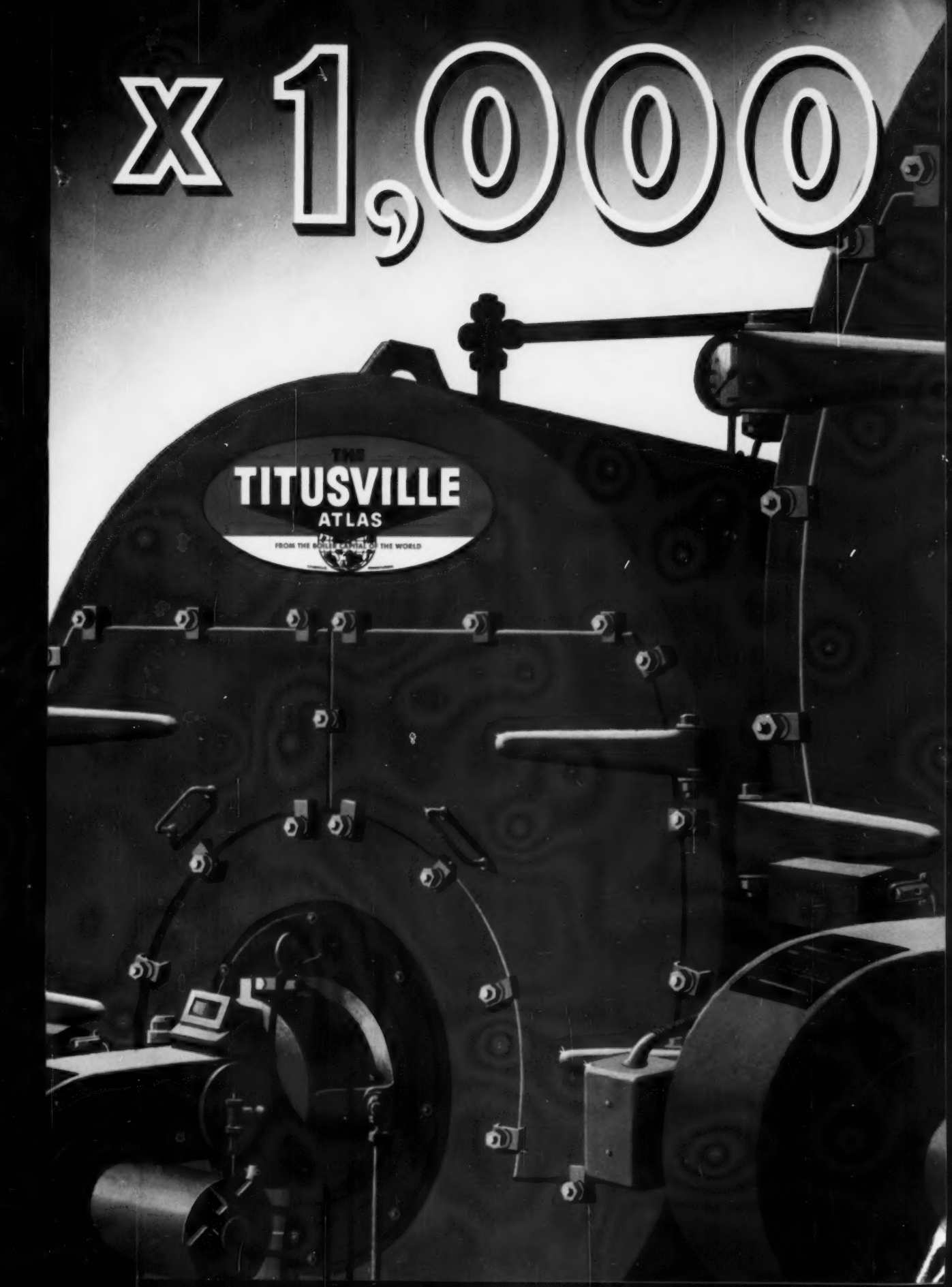
VMA 6063

**THE TITUSVILLE IRON WORKS COMPANY**

TITUSVILLE, PENNSYLVANIA

Division of Struthers Wells Corporation

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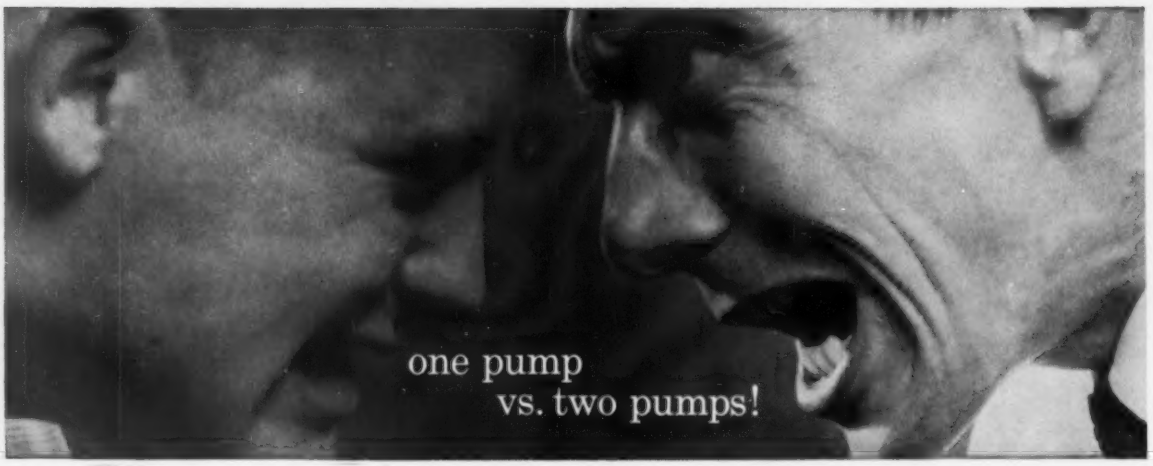
THE
TITUSVILLE
ATLAS




# *Which pumping system is for you?*

Phil Olmstead,
*Chief Engineer*, Goulds Pumps, Inc.
tells you how to find out

The mammoth pump you see here—Goulds Fig. 3420—can handle up to *40,000 gallons per minute!* Think of it—enough to fill an average-size swimming pool in less than a minute!

Yet with two or more smaller pumps in parallel—such as the Goulds Fig. 3405 centrifugals, also shown here—you could fill that swimming pool just as fast, though your strength would be divided.

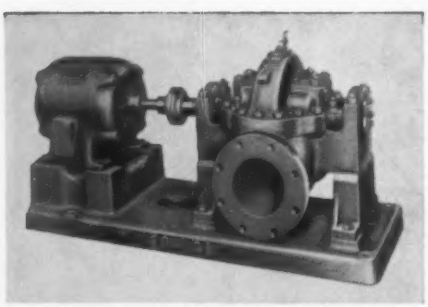
Which is the most effective way to do it?

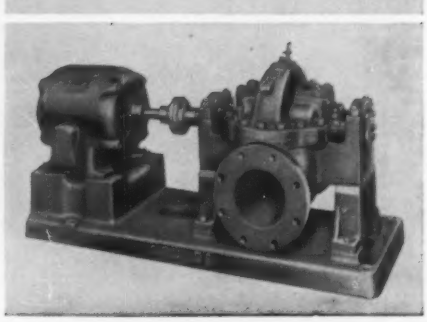
ONE PUMP?

1. With the Fig. 3420, you make just one installation, thereby save installation time.
2. Your installation takes up less space.
3. Your piping is simpler and less expensive.
4. You pay a lower initial cost: one pump, one driver, one coupling.
5. Your operating costs are lower. Big pumps have inherently higher operating efficiencies; you save on power.
6. You service just one pump; maintenance costs are lower.

TWO PUMPS?

1. During critical periods, having a *battery* of Goulds Fig. 3405 centrifugals can save the day: all "eggs" are *not* in one "basket."
2. The flexibility of two pumps lets you accommodate varying needs more efficiently.
3. Smaller pumps are easier to handle, therefore easier to install and maintain.





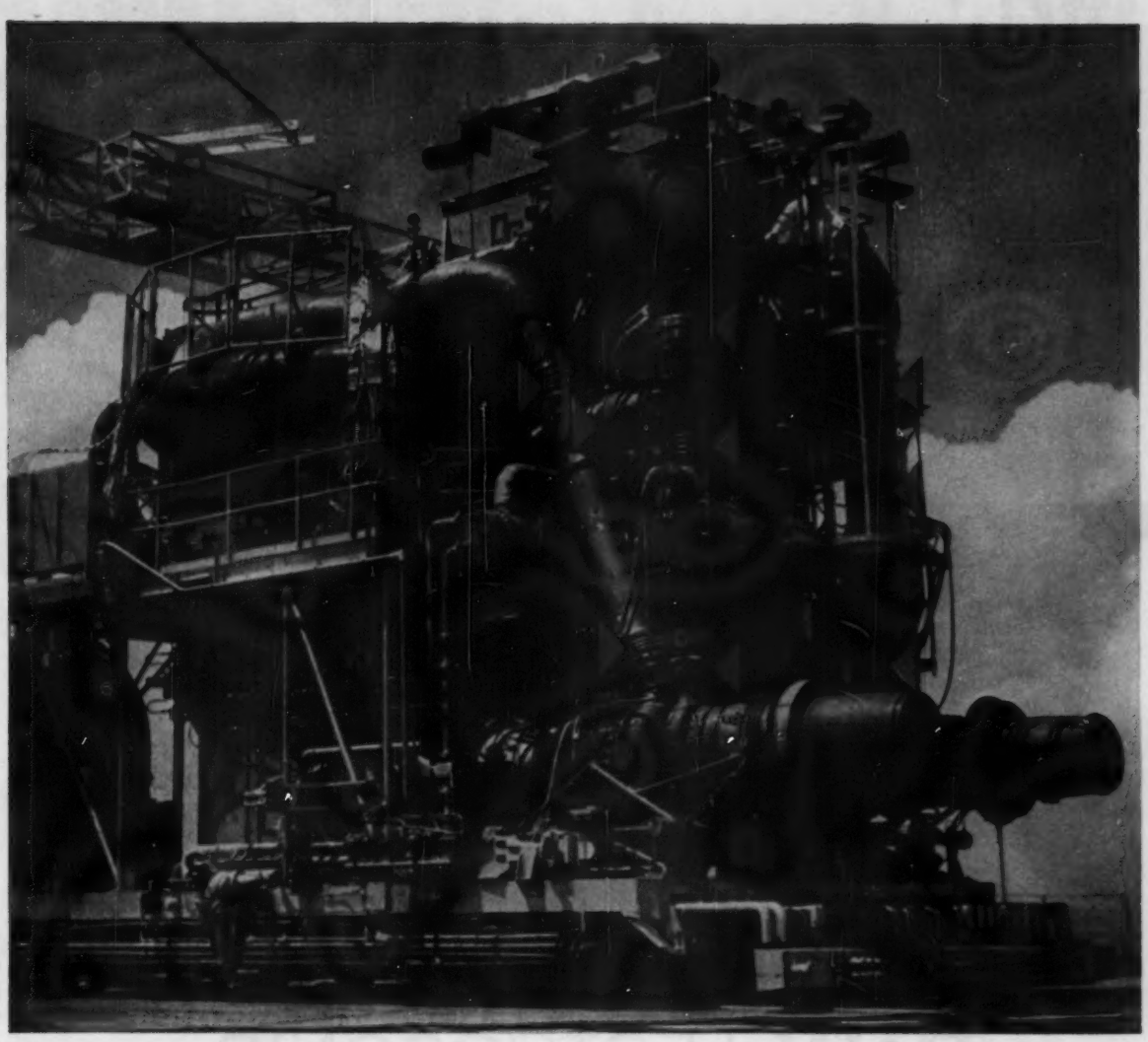
These points might make you wonder which system *is* right for your needs specifically. To be sure *all* important considerations are covered before you make your final decision, call in a pump specialist. Goulds application engineers help pump users make decisions like this all the time, will be glad to help you determine which system most accurately, economically and efficiently meets your needs.

I can help you get in touch with a Goulds application engineer if you write to me, Phil Olmstead, Goulds Pumps, Inc., c/o Dept. PO-40, Seneca Falls, N. Y. I'll also forward any information you might want on the pumps I've mentioned.

**GOULDS GP PUMPS**



For more facts circle 234 on Reader Service card, p 133



# Where expansion joint reliability really counts... YOU FIND ZALLEA

Eighteen Zallea Expansion Joints protect all the piping between compressor, reactor and turbine in General Electric's Heat Transfer Reactor Experiment (HTRE). Sizes range from 18-in. to 30-in. diam. Temperatures are 500 F and 1500 F at 53 psig.

Objectives of HTRE were to develop and test a complete aircraft nuclear power plant system, to determine operating characteristics, and to verify the design of a direct-air-cycle nuclear propulsion system. As in any research involving unknown quantities (in this case the heat source) a basic requirement for all system components was *maximum reliability*. The results of HTRE were successful. Objectives were accomplished. The integrity and life of all system components were verified.

This is another example of Zallea competence in the nuclear field. In fact, Zallea has provided the large majority of all the expansion joints used in atomic, nuclear and missile projects. Our work with almost every major engineering and manufacturing firm in these fields has given us an unequalled background of experience and engineering capacity. It can give you important savings in time and investigation when expansion is involved in piping systems or tanks.

Write for Catalog 56, which contains complete and comprehensive engineering data for Expansion Joints from 3-in. to 50-ft. diam., pressures to 3600 psi, temperatures to 1600 F.

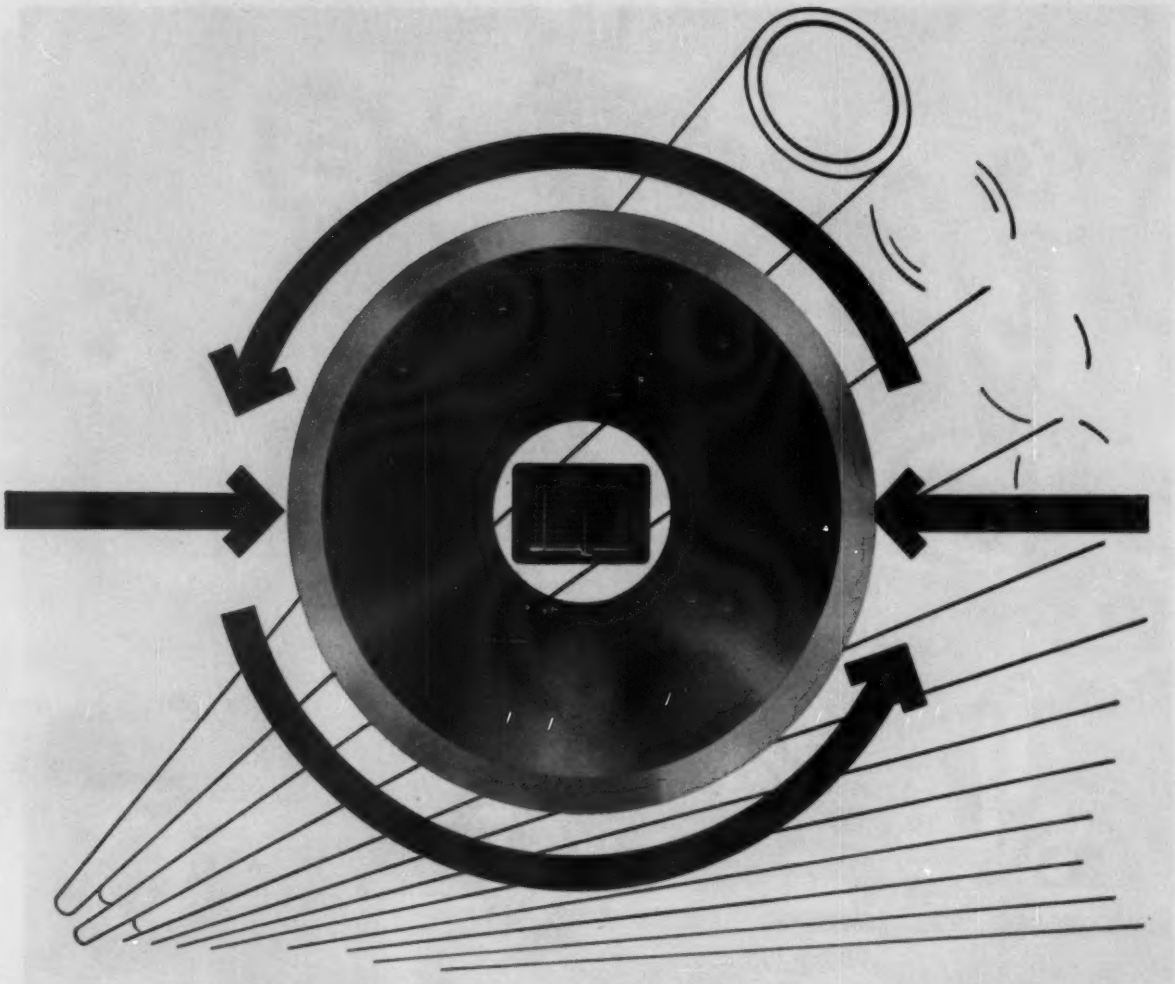
ZALLEA BROTHERS, Taylor and Locust Streets, Wilmington 99, Delaware.

*Zallea* FOR MAXIMUM RELIABILITY

WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS



For more facts circle 235 on Reader Service card, p 133



# B&W LECTROSONIC

## A New Name for Carbon Steel Heat Exchanger Tubing

### Dependability Proved by Five Years' Extensive Field Service

### You get substantial savings with this sounder, more uniform tubing

B&W LECTROSONIC—a new name for heat exchanger tubing—is manufactured under the most exacting methods of quality control in the industry, to give you new standards of dimensional exactness and uniformity, ease of installation, and dependability—plus dollar-saving economy!

You can save on installation time. Every tube fits right and rolls in easily because it's uniform in size and tolerances. It bends easily *with the weld in any position.*

The weld is checked five ways—including 100% ultrasonic inspection—to give assurance of dependability.

This superior quality tubing was developed to meet the needs of the petrochemical industry for a dependable electric resistance welded carbon steel tube that is easily workable, strong, and less costly than seamless tubing formerly required.

B&W LECTROSONIC Tubing is available now either direct or through distributors.

Write today for B&W Bulletin TB-431 for full information—or call your nearest B&W District Sales Office. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

B&W

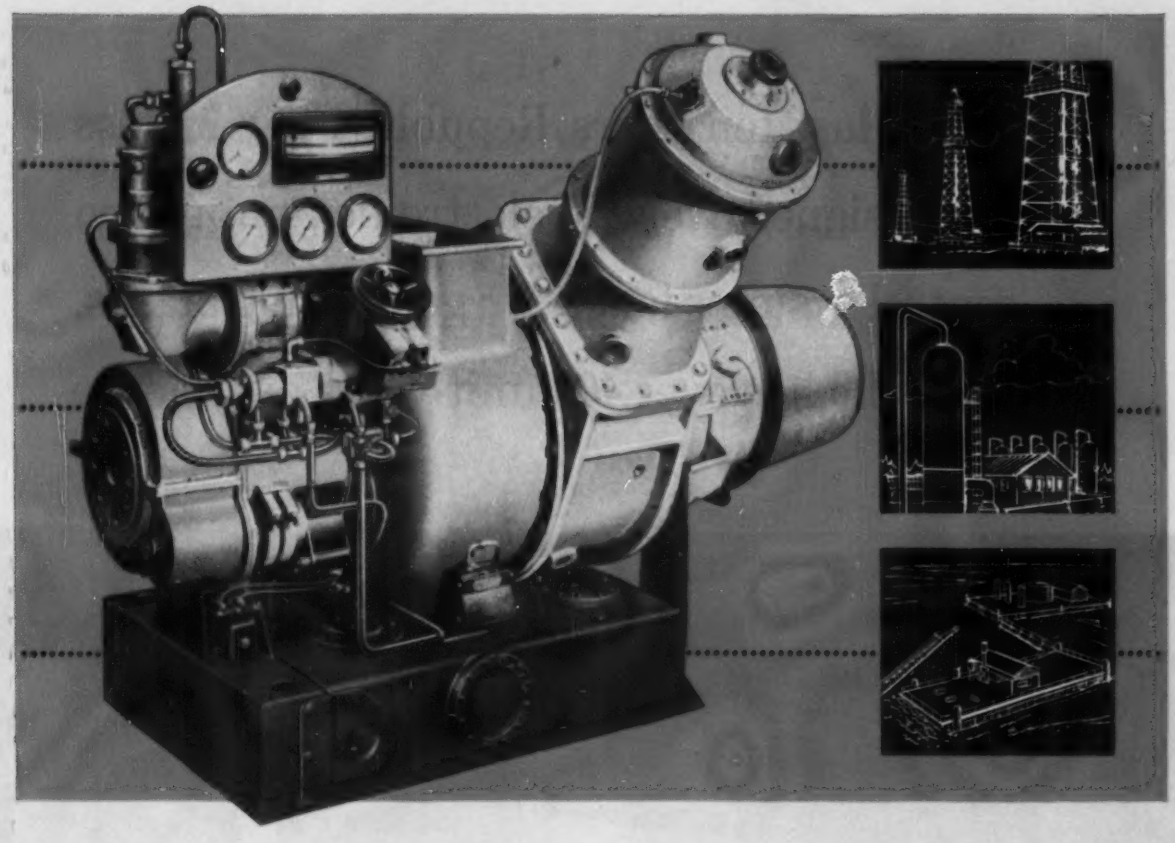
THE BABCOCK & WILCOX COMPANY

***TUBULAR PRODUCTS DIVISION***

TA-9033-WP4

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

# NEW Thompson-Ruston Model "TE" 430 hp Industrial Gas Turbine



This engine will change forever your concept of gas turbine power. That's because it's engineered from the ground up for heavy-duty service . . . designed to bring you all the benefits of gas turbine operation in a package rugged enough to meet the demands of industrial applications.

Compared to aircraft-type gas turbines you've seen before, the Model "TE" offers these important advantages:

**LOWEST COST PER HORSEPOWER**—Lowest first cost, lowest maintenance costs.

**LONGEST LIFE**—The only turbine in its horsepower range designed and built for 50,000 hours service life.

**SIMPLE DESIGN**—Open-cycle type with single-stage centrifugal compressor and single-shaft rotor.

**RUGGED CONSTRUCTION**—Engineered with low component stresses for heavy-duty service.

**EASIEST TO MAINTAIN**—Built to deliver a minimum of 5,000 hours between overhauls, with all components easily accessible for routine maintenance.

Complete specifications and performance data on this rugged new industrial gas turbine are yours for the asking. Write on your company letterhead for the Thompson-Ruston Model "TE" catalog.

TRW

## TAPCO GROUP

***Thompson Ramo Wooldridge Inc.***

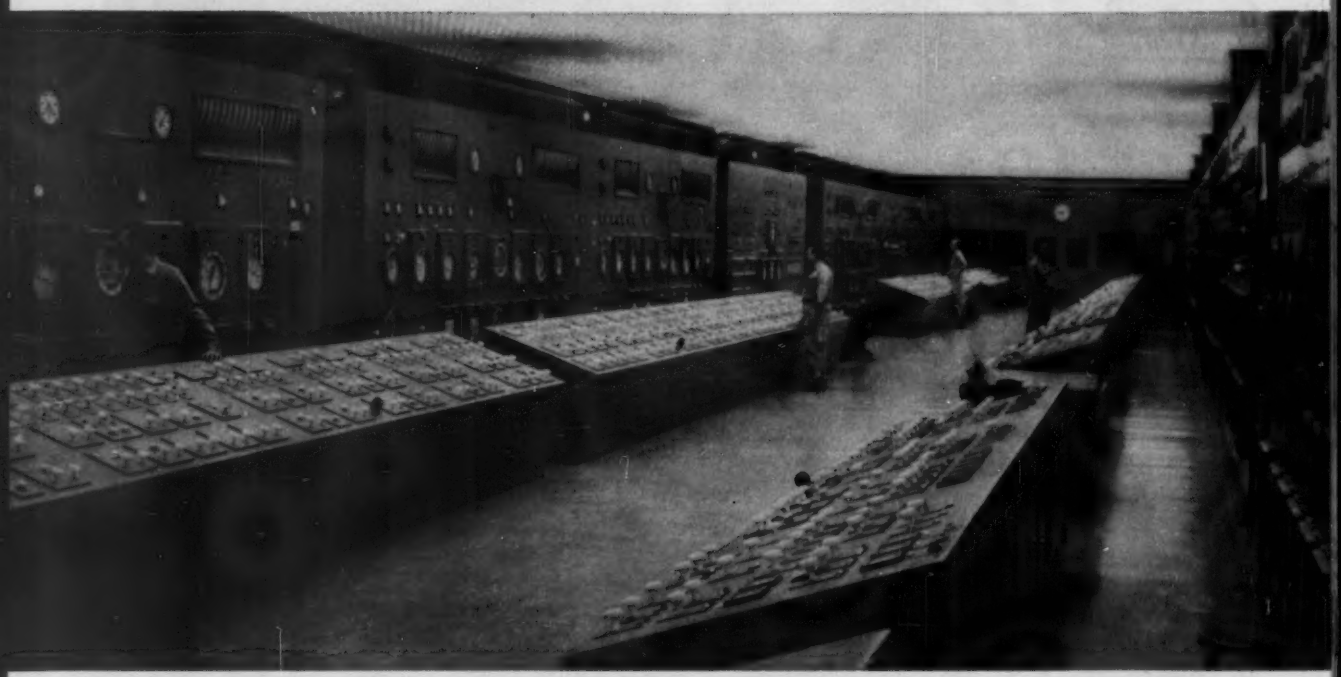
Dept. P-460, Cleveland 17, Ohio



For more facts circle 237 on Reader Service card, p 133

# WHAT REPUBLIC'S TEN COMBUSTION CONTROL

In the last ten years, Republic Flow Meters has designed over 125 electronic combustion control systems for steam generating plants. Republic has over 400 unit-years experience

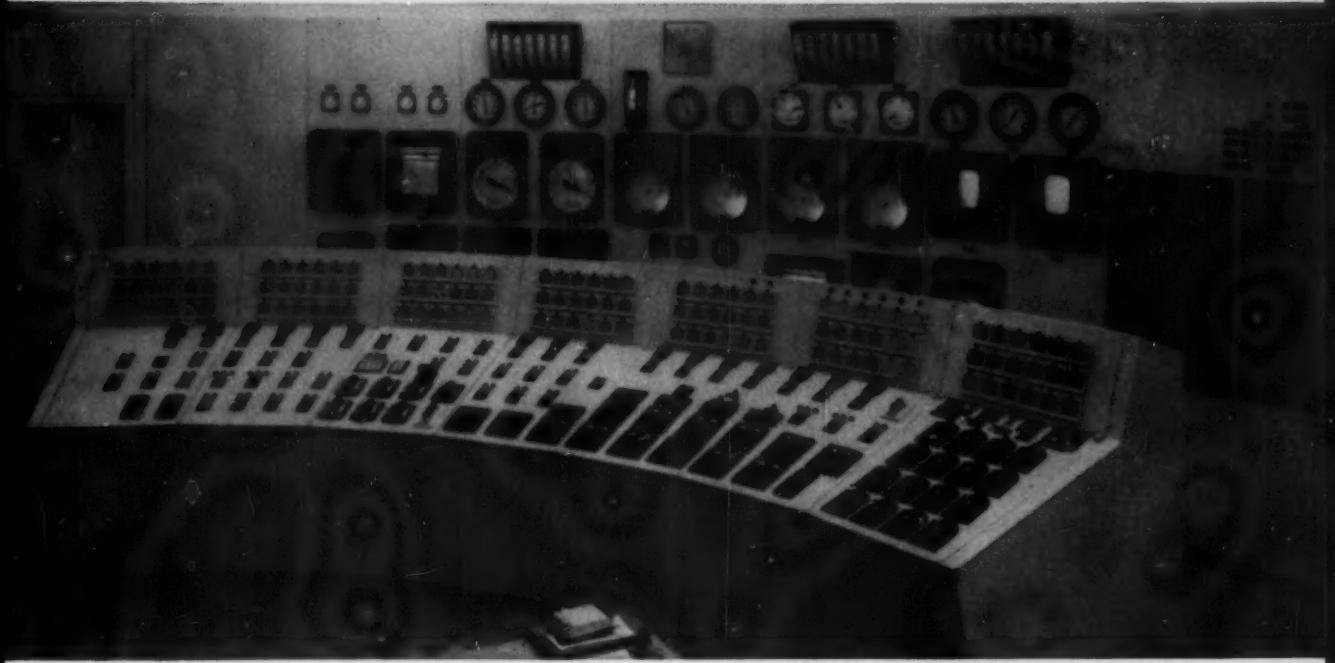


**1949**—The first electronic combustion control system was designed by Republic and installed at Commonwealth Edison's 640,000 KW Ridgeland Station near Chicago. To maintain maximum firing efficiency, 28 cyclone furnaces are individually controlled and integrated with over-all plant operation by a Republic Electronic Combustion Control System.

*Leading manufacturer of electronic combustion control*

# YEARS OF ELECTRONIC LEADERSHIP MEANS TO YOU

with electronic combustion control installations ready to go to work on your system. This is engineering know-how you get only from Republic Flow Meters.



**1959**—This Republic Electronic Control System, one of the most recent to be put into service, is for 121,000 KW, unit No. 1 at the Paul L. Bartow Station of Florida Power Corporation, St. Petersburg, Florida. It controls a 900,000 lb/hr oil and natural gas boiler. Republic is currently engineering an electronic control system for unit No. 2 in this plant.

REPUBLIC FLOW METERS COMPANY
2240 Diversey Parkway • Chicago 47, Illinois
*In Canada: Republic Flow Meters Canada, Ltd., Toronto*
Subsidiary of Rockwell Manufacturing Company

REPUBLIC INSTRUMENTS AND CONTROLS
more fine products by
ROCKWELL


For more facts circle 238 on Reader Service card, p 133

# cost

**CONSOLIDATED SAFETY VALVES relieve overpressures automatically at extremely low cost per pound of steam discharged**

*Consolidated Safety Valve, Type 1511 Series. Cast iron body. Maximum capacity for saturated steam. Sizes: 1½" thru 6". Pressures to 250 psi. Temperatures to 450° F. ASME Standard. ASME Tested. National Board Certified.*

# conscious

Cost-conscious engineers provided maximum capacity in minimum flange size when designing the compact Type 1511 Consolidated Safety Valve. This innovation makes it practicable to reduce the number and/or size of safety valves per boiler. You also have the advantage of smaller, less costly discharge piping.

Fine blowdown adjustment, few working parts, and the positive tightness of optically flat seating add to the total economy of these tough, long-life valves. Get complete technical data and select from the Type 1511 Series the Consolidated Safety Valves that best meet your needs. Write for Bulletin 730.

Industrial distributors in all principal cities are backed by our convenient regional warehouses to give you prompt delivery on the Consolidated valves of your choice.

MANNING MAXWELL & MOORE M&M TRADE MARK

***CONSOLIDATED SAFETY VALVES***

***A product of***

**MANNING, MAXWELL & MOORE, INC.**

*Consolidated Ashcroft Hancock Division • Stratford, Connecticut*
*In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*



For more facts circle 239 on Reader service card, p 133

COPPUS BLUE RIBBON PRODUCTS

Coppus Steam Turbine with Built-In Speed Reducer

***STAMINA*** — You can literally *see* stamina in every dimension of a Coppus Turbine . . . rugged reliability that assures you stable, positive performance. It truly "wins" the Blue Ribbon with which it is marked . . . through advanced design, top quality materials, and thorough testing. With Coppus you're always certain of Blue Ribbon features such as these —

*A totally enclosed governor . . . totally enclosed, independently operated safety trip . . . easily replaceable packing and bearings . . . multiple steam nozzle control . . . brake rim for added safety . . . wide bucket "L" type wheel (optional) for minimum water rate.*

Coppus Turbines are built to customers' specifications, including API and NEMA standards. Sizes from 1 HP to 250 HP. All Coppus Products carry the same Blue Ribbon assurance of reliable performance. For further facts on turbines, send for new Catalog 200. COPPUS ENGINEERING CORPORATION, 164 Park Ave., Worcester, Mass. Sales Offices in *Thomas' Register*.

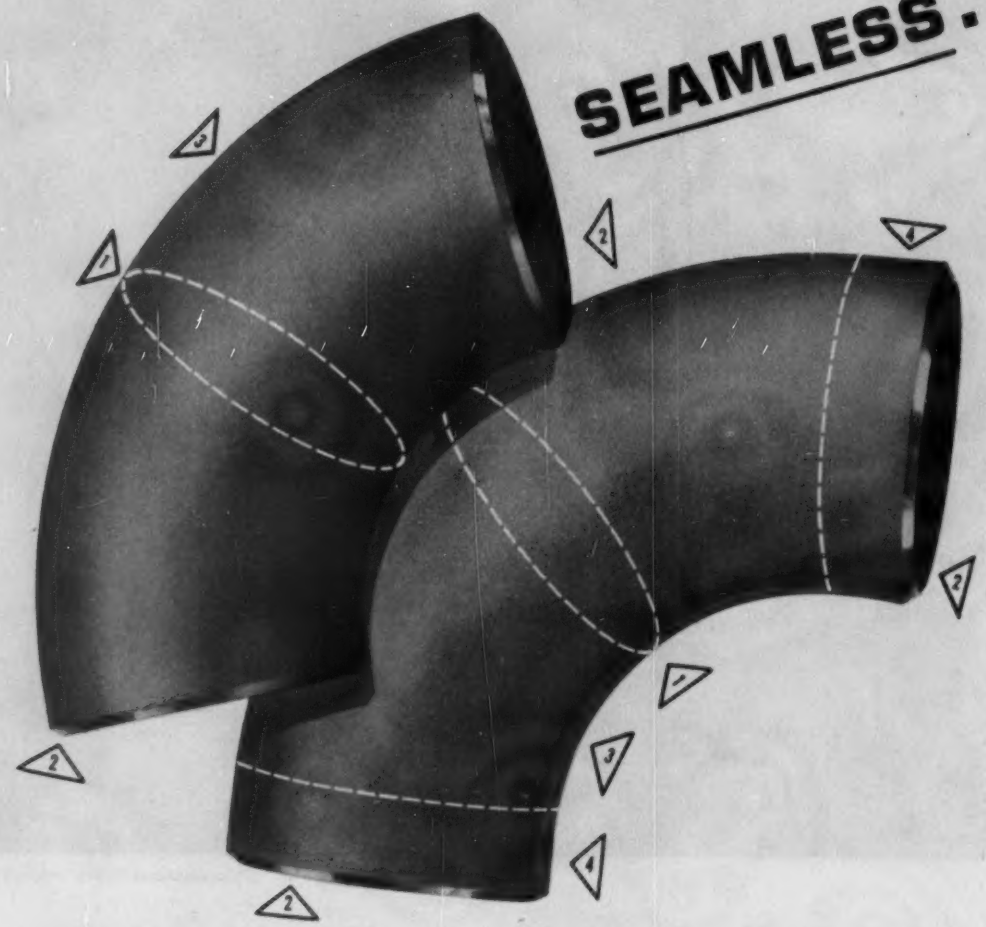
**COPPUS**
**STEAM TURBINES**



For more facts circle 240 on Reader Service card, p 133

# NOW...BOTH!

## SEAMLESS.



**1.** BONUS... All fittings hot-coined in compression throughout entire length—dimensionally true to permit segmenting at any point. **2.** BONUS... Seamless and welded-type fittings with specially machined ends assure uniform thickness and diameters . . . ends that are circle-perfect, plumb and square. **3.** BONUS... Wall thickness and uniformity—greater than required by ASA Standards. **4.** BONUS... Long Tangent bonus on welded-type fittings—NO EXTRA COST—saves pipe, simplifies lining-up, eliminates short welded stubs.

5801

# ..BY MIDWEST

NEW! The finest *seamless* welding fittings ever made. NOW—a hot-coined fitting, dimensionally accurate from end to end . . . fittings forged at controlled heat for superior metallurgical quality . . . with specially machined ends for quickest fit-up and welding! Produced by the newest and most modern equipment—combined with the latest technology in forging, sizing, heat-treating, and machining. Available in all sizes through 24″—long radius or short—90's, 45's, 180's.

# WELDED . . . BY MIDWEST

Welded-type fittings, fully reinforced . . . especially "Long Tangent" bonus fittings . . . always available from stock in carbon steel through 36″ (to order through 48″)—same high quality as always. Also available from stock in wrought iron and chrome-moly. Fittings formed from plate and welded are ideally suited to unusual requirements—heavy wall (2″, 3″, 4″ or more) . . . Hi-Yield, Inconel, stainless, Hastelloy and all other weldable metals. Extra tangent lengths, reducing ells, and special fittings of all kinds are made best as welded-type fittings.

*THE WORLD'S MOST COMPLETE LINE OF WELDING FITTINGS*
*. . . sold through stocking distributors from coast to coast.*

MIDWEST

Write for NEW brochure
SEAMLESS AND WELDED-TYPE
FITTINGS, No. 60-C

**PIPING COMPANY, INC.**
*1450 South Second Street* *St. Louis 4, Missouri*


For more facts circle 241 on Reader Service card, p 133

FOR
SPECIAL
TURBINE
REQUIREMENTS
SEE

# Murray
## TURBINES

- Low Inlet Pressures
- High Back Pressures
- High Speeds
- Variable Speed Ranges
- Precise Control
- Multi-Valve Designs
- Double End Gear Drives
- Vertical Shaft Turbines

*Our nearest representative will help you solve your turbine requirements. His name gladly sent on request.*

**MURRAY IRON WORKS COMPANY • BURLINGTON, IOWA**

Builders of Steam Power Equipment for Nearly a Century

# ENGINEERED METAL PACKINGS

## for Pumps, Engines and Compressors

Selecting the proper metal packing—and packing ring material—assures positive, efficient sealing against gas, air, steam.

**Specifying the right material for metal packings can make a big difference in seal effectiveness and packing life.** Garlock offers a wide choice, each designed for specific temperatures and pressures:

**GRAPHITIC CAST IRON.** Unequaled wear-resistant qualities. Graphite assures continuous lubrication between packing and rod. Recommended against 1500 p.s.i. pressures, 800°F temperatures.

**STANDARD HI-LEAD BRONZE.** Chosen after years of research, this standard bronze has a yield point of 26,000 lbs./sq. in., a tensile strength of 31,250 lbs./sq. in. Can be used against 10,000 p.s.i. pressures, 800°F temperatures.

**HI-LEAD SUPER BRONZE.** Possesses a yield point of 14,750 lbs./sq. in., a tensile strength of 25,500 lbs./sq. in. Due to better wear properties, it can be used at pressures to 40,000 p.s.i., temperatures to 800°F.

**AMBERITE—PLAIN OR GRAPHITIZED.** Tough, strong, high impact strength. Excellent where corrosion and mildly difficult lubricant and wear conditions exist. Apply against 600 p.s.i. pressures, 250°F temperatures. Other grades available to meet various conditions.

**BABBITT.** Used on soft rods and where corrosion is present, lubrication is limited. Standard Babbitt has tensile strength of 10,000 lbs./sq. in. More expensive type has better wear qualities. Recommended for 5000 p.s.i. pressures, 425°F temperatures.

**CARBON.** Used where no lubricant is allowed. Generally affords the best wear-strength combination available. 700°F is recommended temperature limit; pressures may vary according to grade of carbon used.

**TEFLON.*** Far superior to many other rod packing materials because of outstanding chemical resistance, ability to retard wear and friction. Available in carbon- or glass-filled.

# GARLOCK

**Discuss metal packing materials** with your Garlock representative. Call him at the nearest of Garlock's 26 sales offices and warehouses throughout the U. S. and Canada. Or, write for Catalog AD-166. The Garlock Packing Company, Palmyra, N. Y.

**Canadian Div.:** The Garlock Packing Company of Canada, Ltd.

**Plastics Div.:** United States Gasket Co.

**Order from the Garlock 2,000** . . . two thousand different styles of Packings, Gaskets, Seals, Molded & Extruded Rubber, Plastic Products

*Du Pont Trademark for TFE Fluorocarbon Resin

Guniting of stacks and breechings at Ohio Edison Company, Shadyside, Ohio. Contractor: Gunite Concrete & Construction Co., Kansas City.

# Protect steel stacks with corrosion-resistant concrete

Another stack and breeching is being protected with corrosion-resistant concrete linings made with LUMNITE calcium-aluminate cement and suitable aggregates. This lining will resist the corrosive action of flu-gas condensate that forms on stack interiors. Insulation is added, too. Monolithic concrete linings keep stack gases hot, help maintain better draft for greater operating efficiency. In addition, there is less tendency for gases to reach dew-point. And the steel shell stays cool, prolonging the life of exterior paints. Gunited or plastered, installation is fast, easy, economical. The concrete reaches service strength within 24 hours. For greater convenience, manufacturers of refractories offer castables bonded with LUMNITE cement — packaged mixtures ready to use with just the addition of water. For more information, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

L-203

"USS," "Atlas" and "Lumnite" are registered trademarks

**Universal Atlas Cement**
**Division of**
**United States Steel**

Offices: Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco



For more facts circle 244 on Reader Service card, p 133

circle 245 on Reader Service card, p 133 ➤

# Sludge in engine ends with switch to STANODIESEL Oil M

**Situation:** For five years a 1,400 hp. engine in the Municipal Light Plant, Arcadia, Wisconsin, was operated on STANODIESEL Oil M. During this time the engine ran free and clean. It carried a major share of the plant's 20,000 kw. output. A decision was made to switch the engine to another lubricant since it was believed one oil was as good as another.

**What happened:** Within two years the engine had sludged up so much, the oil had to be removed and replaced by STANODIESEL Oil M. Three months later the engine had cleaned up and was again carrying its share of the plant's load.

Clean engine operation is possible with STANODIESEL Oil M because of its superior base stock and its combination of additives that are available in no other oil. Superior base stock and exclusive additives give you these cost-saving operating and maintenance advantages: less sludging, low oil consumption, reduced port deposits, fewer stuck rings, less need for ring replacements, less cylinder wear, lower filtration costs, fewer bearing problems.

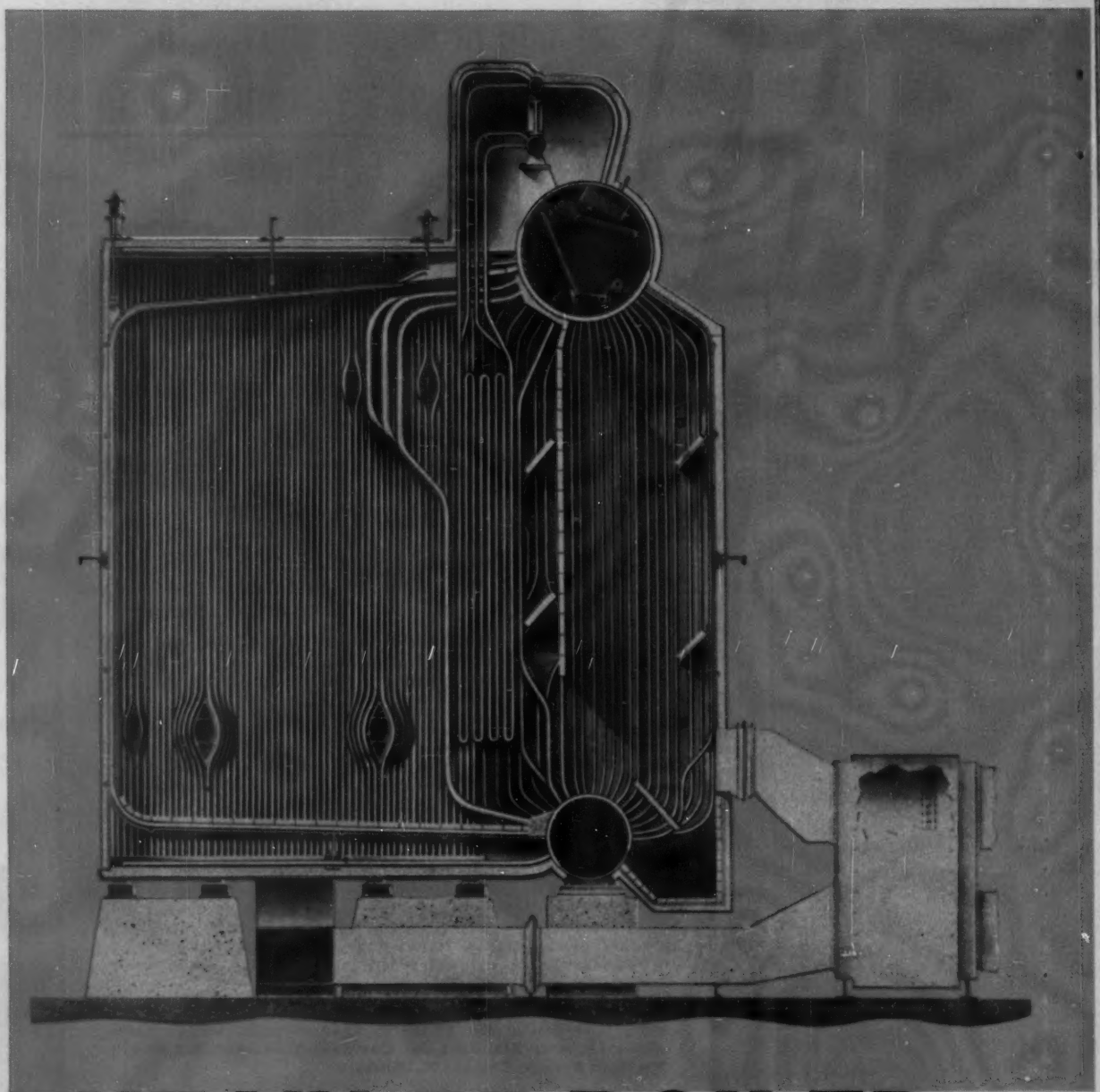
Get more facts about STANODIESEL Oil M. Call the Standard Oil office near you in any of the 15 Midwest or Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**

*You expect more from* **STANDARD** *and you get it!*

The team that got the engine back in shape; (l. to r.) Vernon Schwertel, Ronald Darbo and Standard's Fred Parkinson. Providing lubrication technical service on problems like this one is not new to Fred Parkinson. He's been doing it for 11 years. He has further qualification for such work—an engineering degree from Brown University. Fred has also completed the Standard Oil Sales Engineering School.

*Quick facts about* STANODIESEL Oil M

- Keeps crankcase, pistons, cylinder walls clean.
- Combats deposit and wear problems imposed by economy fuels.
- Maintains film on difficult-to-lubricate parts.
- Eliminates fuel injector and pump sticking caused by deposits on injector barrel and plunger where fuel and lube oil mix.



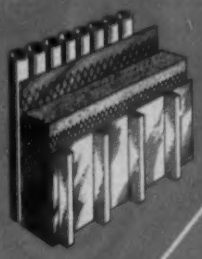
# THE VU-55 BOILER...

The C-E Vertical-Unit Boiler, Type VU-55, is designed to bring central station type of performance to the "standardized" boiler market.

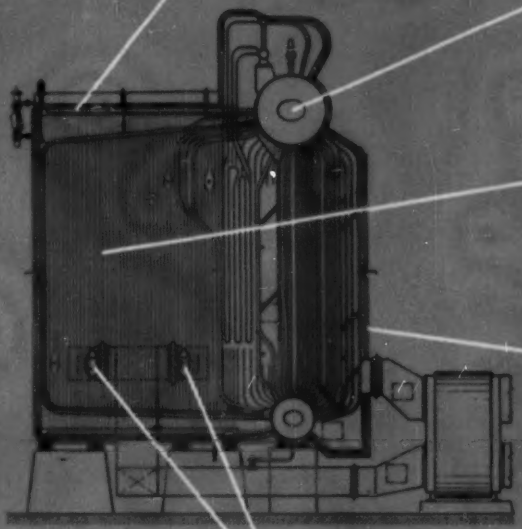
It combines a number of time-tested and service-proved features such as Tangential Burners, pressure-tight casing and tangent furnace tubes. This bottom-supported unit requires no outside supporting steel, is economical of space and has an uncluttered, streamlined appearance.

The VU-55 is available from 70,000 to 150,000 lb of steam per hour. It is designed for three pressure ranges (250, 500 and 750 psi) and can be equipped with a superheater to provide temperatures up to 800 F.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;



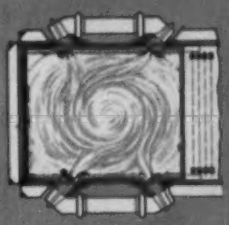
**PRESSURE-TIGHT, SKIN CASING.** A service-proved method of casing construction for pressure-fired boilers in the size class of the VU-55, this casing is designed to assure life-time tightness with minimum heat loss. Pressure firing permits the elimination of an induced draft fan with its attendant operating and maintenance costs. Wall construction consists of tangent tubes backed up successively with welded steel panels, 4 inches of high quality insulating material and an outer steel casing formed as shown to provide adequately for expansion and to give a neat, finished appearance.



**HIGH STEAM QUALITY.** The VU-55 has generous water capacity and steam reservoir space. Its drum internals are exceptionally effective in producing high quality steam at all ratings.

**TANGENT FURNACE TUBES.** The VU-55's furnace tube arrangement provides complete heat-absorbing, water-cooled protection on all furnace walls. Furnace maintenance is minimized, refractory expense is eliminated.

**STREAMLINED EXTERIOR.** The over-all appearance of the VU-55 reflects the efforts of its designers to achieve a completely unobstructed casing, while retaining adequate access wherever required and every facility for convenient operation. There are no outside downcomer tubes, and the ducts from air heater to burners are beneath the furnace floor.



**TANGENTIAL FIRING.** More than 20 years of application experience have established the exceptional advantages of tangential firing. About 90 percent of Combustion's large utility installations use this advanced method of firing. Flame streams from the four burners impinge upon one another at high velocity, as shown, creating a turbulence unattainable by any other method of firing. The result is rapid and complete combustion. As the gases spiral upward, they sweep all furnace heating surfaces, assuring a high rate of heat absorption.

# a "standardized" boiler with "custom-built" performance

The unit is symmetrical in design, performs efficiently over a wide range of output, and is exceptionally easy to operate and maintain.

When you are considering additional steam capacity in the quantity range mentioned above don't fail to investigate the advantages of the VU-55.

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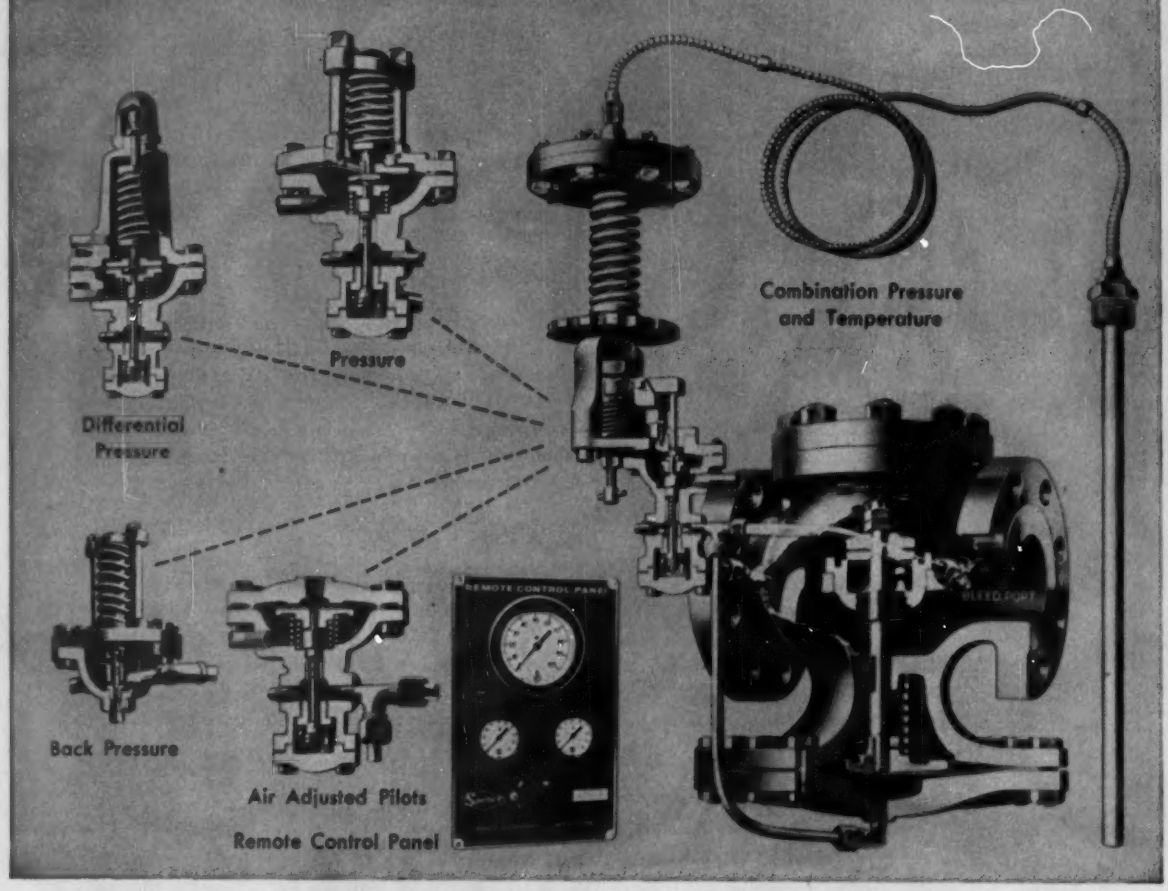
# *All Pilots Fit All Main Valve Sizes Downtime, Maintenance, Inventory Reduced*




Let's start off by admitting there's no such thing as a "maintenance-free" regulating valve. Any valve that automatically controls temperatures or pressures within close limits can be affected by dirt in steam lines.

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The pictures above show a few of Spence's wide line of automatic regulators. For more information write for Bulletin TE.

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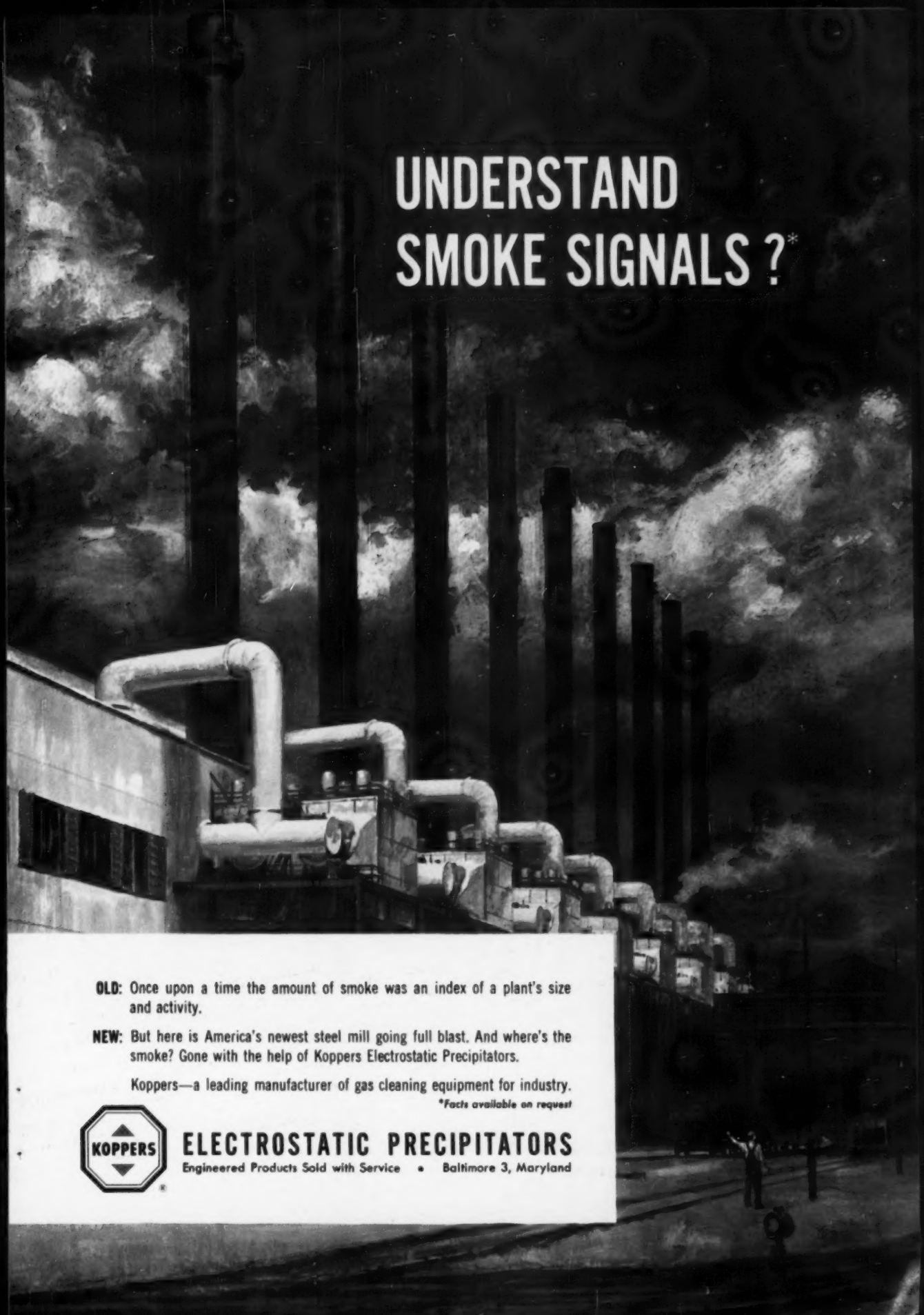
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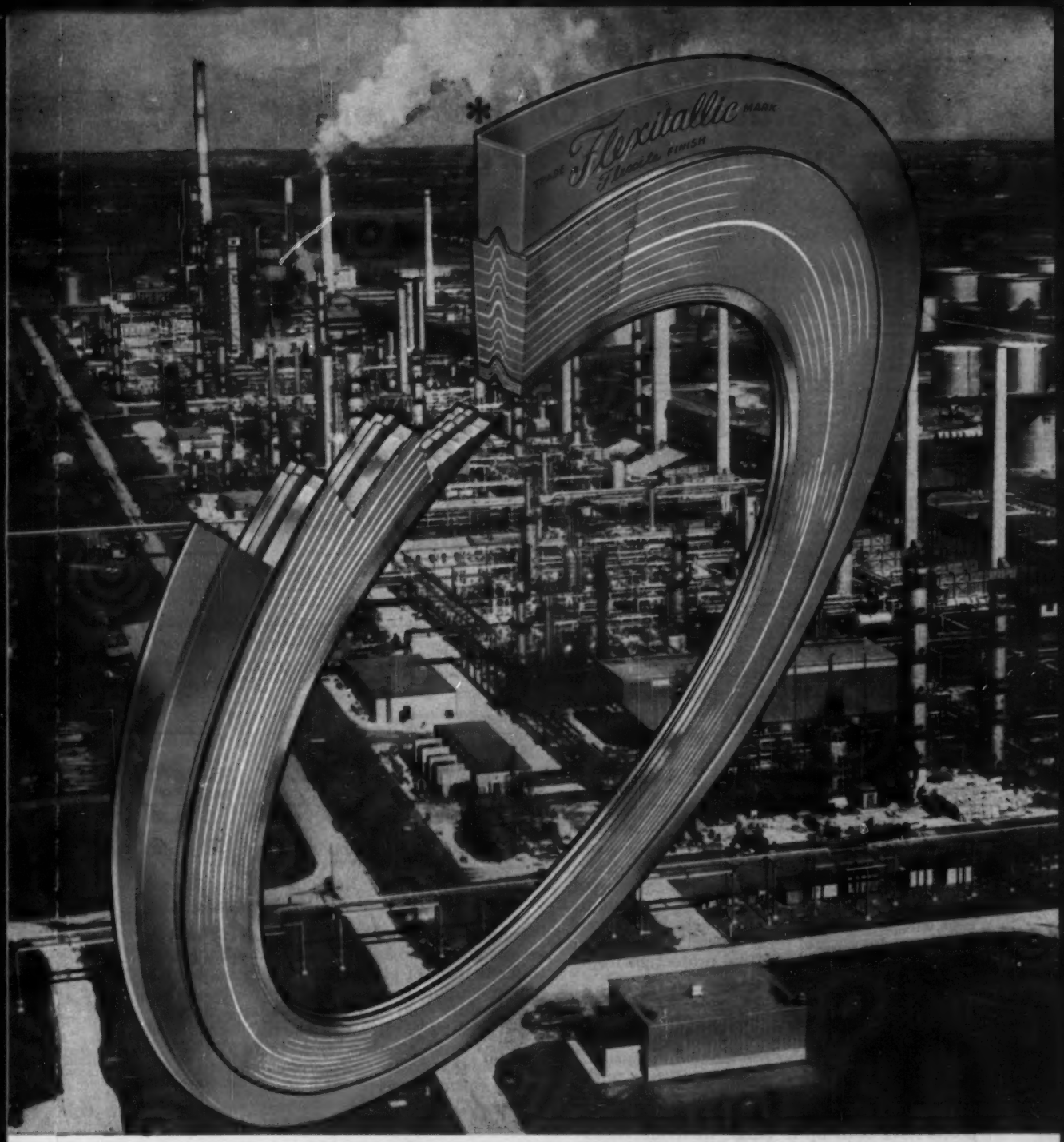


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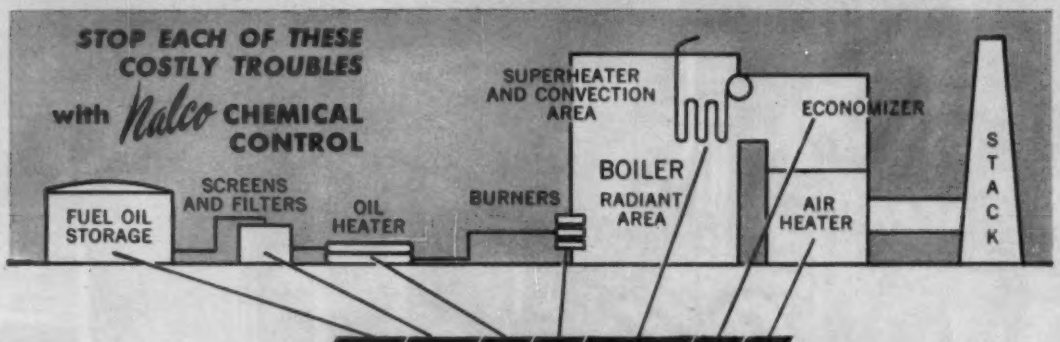
# Nalco Residual Fuel Oil Treatments Protect Boiler Systems from Storage to Stack

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LOUIS N ROWLEY, EDITOR • APRIL 1960 • ESTABLISHED 1882 **Power**

# The imagination stirrers

Development of heavy equipment for energy systems is, of necessity, a painstaking process of step-by-step improvement. Not unnaturally, our thinking often tends to run the same way. And that's why it's so important to have engineers who are "imagination stirrers"—men with vision that leaps beyond the next few steps to see the exciting possibilities promised by continued progress.

Some "imagination stirring" in the field of high-pressure boiler-feed pumps is being done right now by E C Schmachtenberg and our old friend and POWER author, Igor Karassik. As their contribution to the current Steam Power Symposiums sponsored by Worthington Corp they trace the dynamic development of the feed pump to meet the challenges of higher steam conditions and larger generating units. In slightly more than 30 years, pumping pressures have gone from 1500 to 6500 psi and power requirements for a single pump have leaped from about 1000 to over 20,000 hp.

To meet these tougher requirements the concept of the double-casing pump was developed, new materials have come into use, speeds of the order of 6000 to 9000 rpm are being employed with consequent changes in drive methods. Along with these developments have come refinements in hydraulic design and mechanical improvements that have enormously extended the time before internal overhaul is needed.

But this is history. What stirs the imagination is the logical extension of these trends to meet the challenges of the future. Looking ahead, the authors see these possibilities: Single-stage high-pressure feed pumps, operating at speeds of 30,000 to 40,000 rpm. Super-hard materials yielding almost infinite life of wearing parts. Lubrication and sealing simplified or eliminated by water-lubricated bearings and canned-rotor construction. And they conclude with the belief that the day will come when a boiler-feed pump can be built, tested, and welded permanently into the feedwater circuit, without ever requiring dismantling for inspection or overhaul.

Whether the developments these pump "pros" forecast come to pass exactly as they visualize them is not really important. What *is* important is that our engineering thinking in all areas should be leavened occasionally by such "imagination stirrers," by bold efforts to visualize the long-range outcome and total impact of the many detailed improvements being carried forward today.

And it is important also, I believe, that each of us should cultivate the ability to give occasional free rein to our own engineering imagination. Not to dream idly of what the future may hold, but to purposefully explore the logical extensions of what we are doing today. As the pace of technical progress accelerates, the future moves closer and becomes increasingly important. It must play a consciously greater role in all our engineering thinking if we are to be ready for tomorrow, which will surely be bigger and more complex than today and which will come much sooner than we think.

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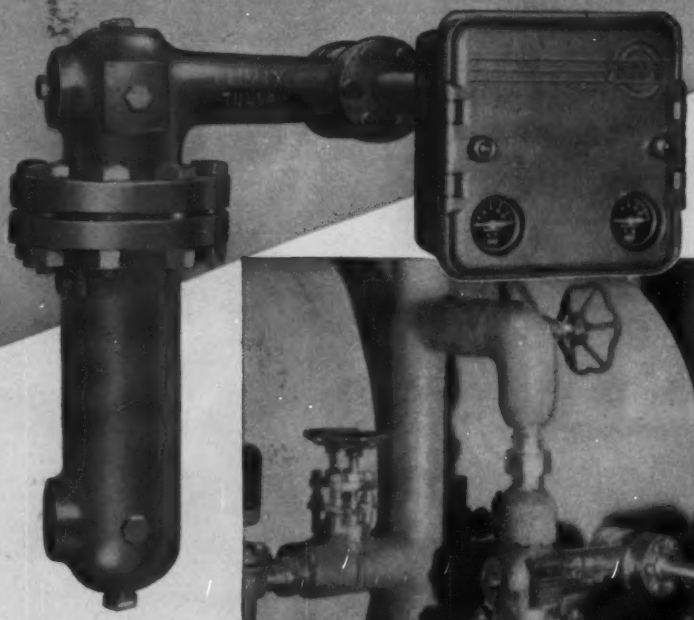

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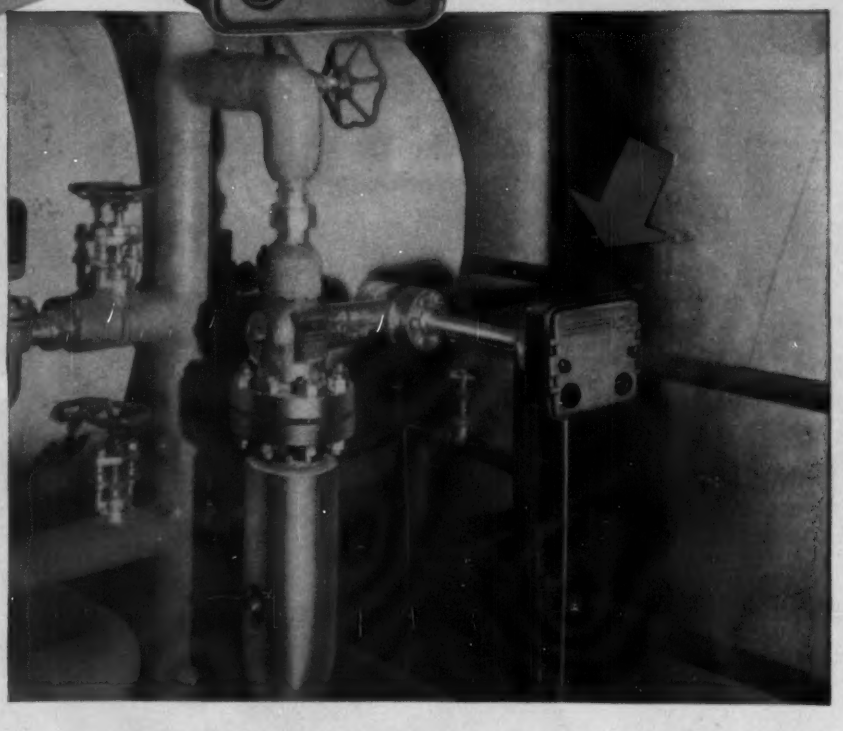

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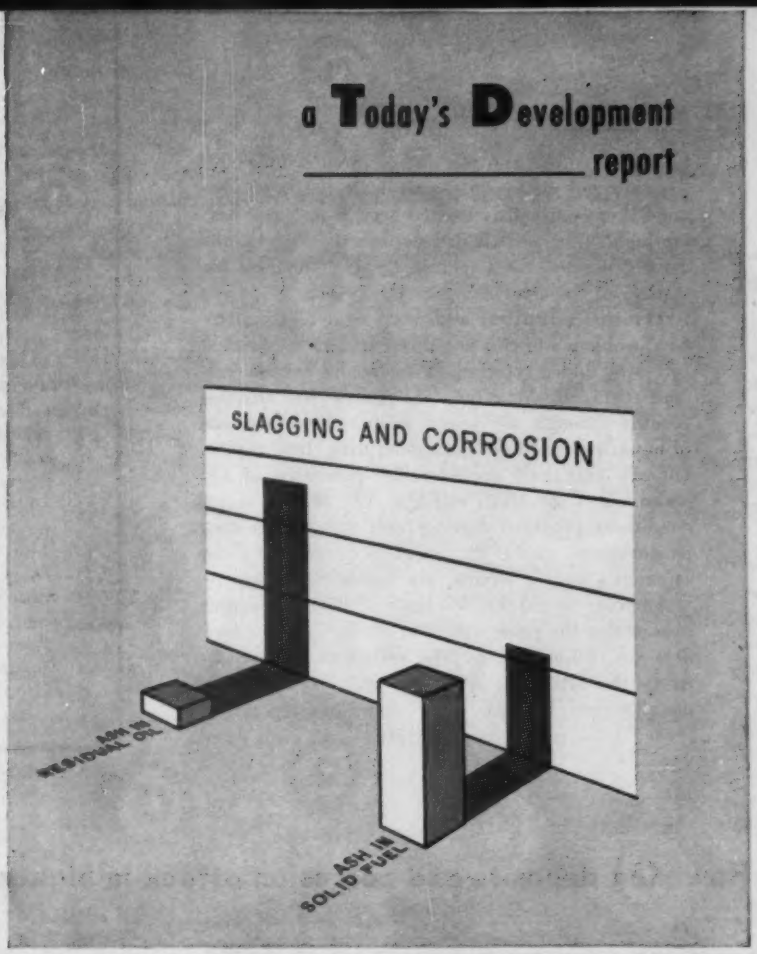
Design and equipment application section

B G A SKROTZKI
Associate Editor in Charge

a Today's Development report




**Residual-oil ash, though minute in quantity compared with most solid-fuel ash, can outstrip latter in vicious attack on combustion equipment. Here's an up-to-date report on . . .**

# Industry's battle with fuel ash

By R C BELLAS
Associate Editor

During the years following World War II we've seen significant advances in technical know-how in many fields. Prominent among these are the developments in petroleum-refining techniques and high-temperature high-pressure steam-generator designs. Though the two are not generally considered specifically related to each other, result of the former has had, and continues to have, a sometimes serious effect on the latter. Steam generators, burning residual oils (commonly termed No. 6 or Bunker C) produced at the "tail end" of petroleum-refining processes, began to experience more and more difficulty due to slag deposits and corrosion. Too, these effects of residual-oil ash became more pronounced in gas turbines, diesel engines and other combustion equipment.

Initially, the picture didn't quite come into focus because there was really nothing new about oil-ash slagging and corrosion. It had been around for years, but was never more than a mild problem in most cases. Now its attack became vicious. Actual amount of ash increased somewhat, but total amount was still insignificant as compared to that of most coals—yet slagging and corrosion effects were beyond all proportion.

continued

Coal-fired equipment, too, began to show effects of slagging and corrosion, particularly the latter, beyond those normally expected even from coals having high sulfur and alkali ash. Investigation results usually pointed the finger at residual oil used for startup or low-load firing as the culprit.

**Overall situation** added up to a costly, complex problem and concerned researchers marshalled forces to find a solution. Two factors became evident: (1) Residual-fuel-oil quality had dipped steadily through the years; higher concentrations of impurities had to be contended with (box, right). Oil ash contained considerable quantities of vanadium and the alkali sulfates. (2) Higher steam conditions provided furnace and superheater-zone temperatures above the melting points of these impurities which, molten, are highly corrosive.

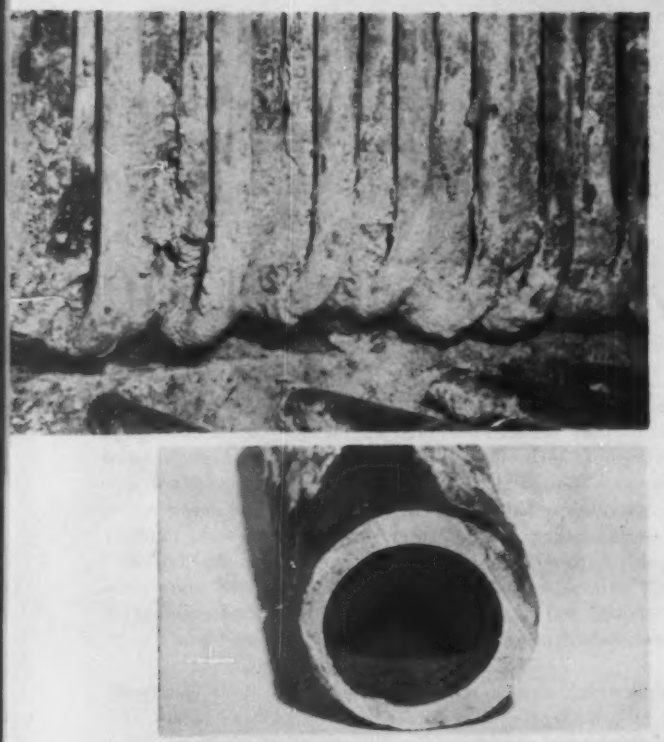
Attempts to rid the residuals of their impurities proved that the game wasn't worth the candle. Two defenses, improving metal's resistance and weakening the attackers, were set up. The battle is being waged in both high- and low-temperature areas. Let's review how ash attacks in each case.

## Why residual-oil quality is low

Refineries are in business primarily to produce highest-possible yields of gasoline, high-value distillate hydrocarbon fuels and quality lubricants. Down through the years, accent has been on improving such yields. Indicative of successful effort is today's gasoline yield: some 60% more per bbl of crude than in 1920.

Today's residual oils are byproducts of modern refining techniques. They're priced to compete with low-cost fuels such as coal. Any effort to upgrade quality means that residual's cost must be upped, pricing it out of the market, or the expense spread over high-value distillate products. This could not be economically justified. Some of today's crudes, particularly imports, are higher than ever in sulfates and vanadium, which are concentrated in the residual. With trend to produce less residual per bbl of crude, corrosive ash continues to rise.

## How slag deposits and corrosion attack in high-temperature zones



**SUPERHEATER ELEMENT,** top, shows effects of severe slag deposits, which have been partially removed by power tools. Loops are completely bridged. The tube section, below, shows 50% loss of wall thickness due to corrosion

Many theories have been advanced as to just how slagging takes place. Some lend themselves to acceptance more than others, many are debatable. However, there's general agreement that ash particles stick to a hot surface much easier than they do to a cold surface. It's generally agreed that if ash is below its fusion temperature it's more apt to bounce off than stick to the hot surface. But if ash is plastic, sort of "chewing-gummy," as it contacts the hot surface—chances are it will stay there.

It follows that temperatures in today's boiler furnaces and gas-turbine combustors, being higher than fusion points of ash's vanadium and alkali sulfates, provide ideal rendezvous conditions for sticky ash particles and hot surfaces. With the two in intimate contact and ash showing no desire to upset the status quo, the metal surface is likely to be condemned to slow death.

**Investigators,** while perhaps not entirely sure of *how* the corrosion phenomena occurs, are agreed as to its effects and the imperative need for continued research aimed at solving the problem. Temperature appears to be most-significant factor in the overall picture. It's primarily responsible wherever slagging occurs, and its effect on corrosion *rate* is ominous considering the desire for higher efficiencies possible through higher-temperature operation. Slagging, in itself, adversely affects heat transfer and disrupts designed gas-flow patterns. Slag type determines degree of difficulty in keeping heat-transfer surfaces clean.

**Slagging problems** have been known and suc-

cessfully combated for years. But residual-oil ash deposits are apt to produce in high-temperature zones a hard slag which almost defies mechanical removal. Beneath, the alkali sulfates and vanadium are in intimate contact with the metal and begin their corrosive action. Deposit thicknesses generally reach a maximum of about 0.5-in. on furnace tubes. Additional deposits don't solidify, but flow down the tubes and collect in a molten mass on the furnace bottom. However, some corrosive agents in the additional deposits *don't* leave with the flowing slag. Result: adhering deposits tend to become enriched in corrosive ash.

Here, temperature steps importantly into the picture. As temperature goes up, so does corrosion rate. Top photo, opposite page, shows typical rock-hard scale (partly removed) deposited on a superheater element. Note that deposits have completely bridged adjacent loops. Lower photo is a section of a superheater tube (not from element above) which shows typical wasting due to oil-ash corrosion. Tube surface facing the gas stream loses most metal; tubes soon can become unfit for service.

**Exact temperature level** where slagging and corrosion problems become acute is difficult to pin down. Variables result in relatively similar effects on equipment operating with some difference in temperature. It is generally admitted that not enough is known about what actually happens to impurities in residual fuel oils when they're exposed to combustion temperatures. Reactions between the elements' particles and combustion gases can affect fusion temperatures in somewhat unpredictable degree. However, it's generally agreed that significant slagging is apt to occur as metal-surface temperatures approach 1000 F. Between this point and 1200 F it's a good bet that slag will be in a liquid-running condition, unquestionably stepping up corrosion rate.

When slagging and corrosion first focused attention on oil ash as a bad actor, it appeared that its attack was principally directed at nonpressure parts. Superheater supports, bars and spacers suffered severe metal loss, in some cases were entirely eaten away. Some instances of severe pressure-parts corrosion were reported, but only a few isolated cases. Attack on nonpressure parts was credited to the facts that these parts were exposed to relatively high gas temperatures, had no practical means of effective cooling and, in the case of superheater supports, carried a considerable load. It seemed obvious that one counterattack strategy would be to cut the physical size of the affected parts and, if possible, reduce their operating temperatures. It was obvious, too, that this would be a tough nut to crack in the foreseeable future.

**Search for materials** better able to withstand the mounting attack produced the disturbing revelation that pressure-part materials offered no better defense. Now the problem was compounded. Before discussing how this high-temperature-corrosion challenge is being met, let's review additional problems set up by low-temperature attack.

## Residual-oil ash can speed low-temperature corrosion

Metal corrosion can occur readily at either end of the pH range. In the preceding discussion of high-temperature corrosion we mentioned the alkali-sulfates and vanadium content of oil ash. No one is quite sure what proportion of the attack can be attributed to each, but it's a safe bet that the alkaline salts try to take their share of metal into solution. In low-temperature areas, acid gets in its licks. How it goes about doing this isn't exactly news, but some conditions producing excessive quantities of acid are relatively new experiences in burning residual fuel oils.

**"Cold-end" equipment**—in boiler operation, air heaters, economizers, ductwork and stacks—can take a real beating from acid attack. Top photo, this page, shows the almond-shell-thick remains of some air-heater tubes. Lower photo shows all that is left of a once-husky air-heater-element bracket. Corrosion is directly related to sulfurous- and sulfuric-acid production due to sulfur combustion products, sulfur dioxide and sulfur trioxide, combining with moisture. Sulfuric-acid production, which depends on dew-point temperature, governs extent of this kind of corrosion.

**Boiler-operation picture** is complicated by need for low-temperature flue gases to realize high boiler efficiencies, despite resulting corrosion problems created by sulfuric-acid formation. This low-temperature corrosion attack is faced with any boiler size, from central-station units down to those used in small industrial and institutional plants. High-temperature corrosion, on the other hand, is chiefly a problem with units operating at and above the 1000-F range.

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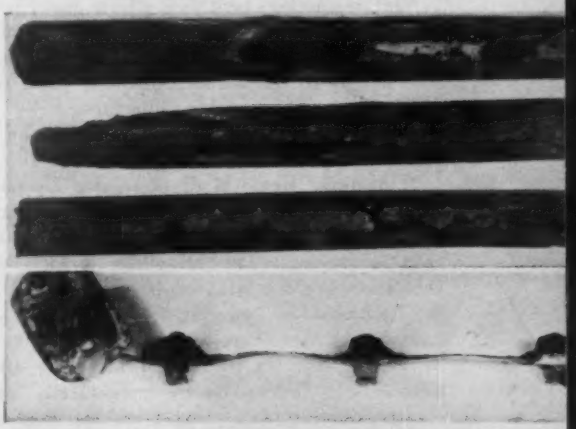


**SULFURIC-ACID** formation literally causes "cold-end" equipment to disappear. Air-heater tubes, top, and heater bracket, below, are mere shells of their former selves. Answer to this is use of additives to depress acid dew point

**Mechanics** of sulfuric-acid formation probably can best be portrayed by comparing it with the old contact process of manufacturing the acid. Sulfur dioxide from burning raw sulfur is passed at high temperature through a retort in the presence of a catalyst—either platinum or vanadium. Catalytic action converts sulfur dioxide to trioxide; adding water completes cycle, forming sulfuric acid.

When fuels containing sulfur compounds are burned, combustion byproducts will be the oxides of sulfur, generally sulfur dioxide. As dew-point temperature of water (from moisture in combustion air or chemically formed in the combustion process) is reached, sulfurous acid would result even if no catalyst were present. But sulfurous-acid corrosion would be relatively low in comparison with today's low-temperature corrosion problems.

Residual fuels contain vanadium and iron in addition to sulfur. Ash or slag formations, in turn, contain oxides of iron and vanadium. With catalyst thus provided, sulfur dioxide converts to trioxide and sulfuric acid forms in much the same manner as the old contact process. Hot metals can catalyze oxidation of sulfur dioxide to sulfur trioxide in the presence of oxygen. Active particles in the gas stream also, by catalysis, add to the volume of sulfur trioxide as it moves with the gases to cooler areas in the boiler.

**Conversion percentage** can vary drastically from unit to unit and from one condition to another. Actual sulfur content of the residual doesn't necessarily indicate amount of sulfur dioxide that will be converted. It appears that amount of vanadium- and iron-bearing ash or slag plays a major part in the conversion. Important is that small concentrations of sulfur trioxide can significantly increase acid dew-point temperatures, promoting sulfuric-acid formation. Let's take a look, now, at what's being done to combat slagging and corrosion in both high- and low-temperature zones.

## Industry launches counterattack on corrosive deposits

As we mentioned earlier, first reaction to oil ash's virulent attack was attempt to eliminate the corrosive elements from residuals or, at least, reduce them to a point of relative impotence. It quickly became apparent that residual producers could not economically justify upgrading (box, p 84).

Next, researchers bent their efforts, many pooling their knowledge, to find any means by which the ash-forming constituents could be sidetracked before oil got to the burner. Methods tried, results obtained can be quickly summarized by these quotes from the ASME's research publication, *Corrosion and deposits in boilers and gas turbines:*

"Filtration. Removal of oil-soluble compounds, including the organometallic complexes containing vanadium, is not accomplished by simple filtration."

"Centrifuging. The oil-soluble organometallic substances are not removed by centrifuging."

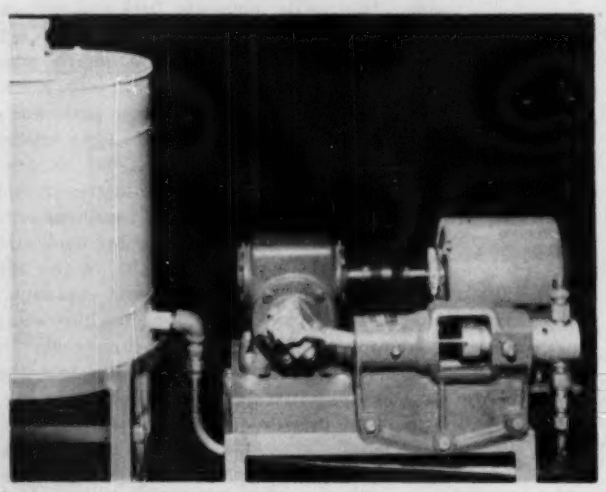
"Treatment by solvents. Methods of solvent treatment . . . are expensive, usually more so than distillation, involve substantial losses of oil and cannot be considered to be economically feasible for the treatment of low-cost residual fuel under ordinary circumstances."

"Distillation. The residual fuel is already the byproduct of a commercial distillation process, and further treatment by this means has been ruled unjustifiable by the refiner. In any event, the ash-free product would be a higher-value product in the distillate price range, leaving a heavier residue even more difficult to dispose of economically."

"Treatment by ion exchange. A large number of ion-exchange resins were tested in attempts to remove vanadium. Wide ranges of experimental conditions were studied . . . attempts were unsuccessful." Very clearly, these efforts show that finding a simple, low-cost way of ridding residual fuel of undesirable ash constituents would be difficult.

In the meantime, some people weren't so sure that vanadium was the chief terror others believed it to be and set out to determine who was right.

**Some conclusions:** A major oil company states that crude oil coming from Texas and Oklahoma frequently contains appreciable quantities of vanadium and, in some cases, amount is as high as that found in Venezuela crudes. It's conceded that molten vanadium pentoxide will attack iron and iron alloys. But they point out that almost any oxide, as well as sulfur, in the molten state will also attack



**SLURRY FORM** is one method of injecting additives into fuel stream. Proportioning pump gives needed feed control

iron. They found that when they keep boiler-metal below 950 F they don't experience corrosive attack, but slagging and scale become troublesome.

A prominent metallurgist believes his tests have demonstrated conclusively that presence of vanadium oxide in oil or oil-ash deposits is not a requisite for high-temperature corrosion.

**Tests** run by an electrical-equipment manufacturer indicate, it's stated, that vanadium content in fuel-oil ash does not seem to have an accelerating effect on corrosion rate. In fact, sodium sulfate alone was found to be more corrosive than mixtures of vanadium oxide and sodium sulfate.

Among many on the other side is a large boiler manufacturer who disagrees with these findings, but it must be said that their test methods have been different. Differences may arise because, as experts agree, it's very difficult to duplicate actual job conditions in a lab test. Moreover, it's often difficult to duplicate conditions on two similar boilers operating in the same plant.

**These efforts have paid off** even so, and are continuing to pay as the search goes on for more and better weapons to battle both high- and low-temperature corrosion. Today, it's generally agreed that most consumers of residual fuel oils need not encounter serious difficulties regardless of oil's source or vanadium content. However, this holds true only under certain conditions. If metal temperatures are below ash's melting point or if furnace design prevents oil-ash particles' contact with hot metal surfaces, little corrosion occurs. If ash deposits can be kept from reaching a molten state, corrosion will be negligible.

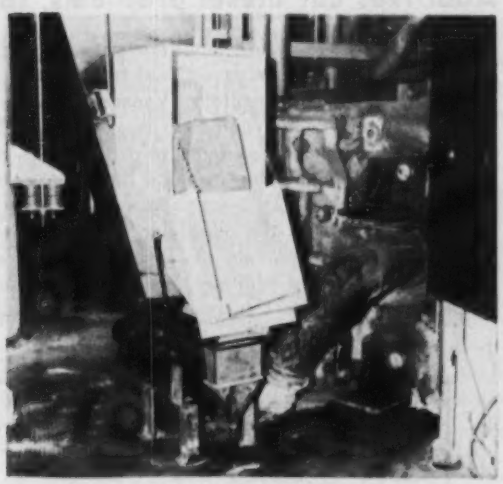
**Principal difficulty** with vanadium pentoxide is that it acts as a flux, tends to lower ash fusion temperature. Apparently, much high-temperature corrosion is attributed to presence of an alkali-sulfate ash which melts easily in presence of vanadium oxides. Effective weapons would be oil additives to raise ash fusion temperature, so experimental work was pushed along these lines. A major boiler manufacturer's work with additives such as aluminum, calcium and magnesium oxides proved highly successful in getting a soft friable ash, more easily removed and less corrosive than hard slag deposits. Other additives such as dolomite and a number of proprietary compounds became available. Some of the latter produce excellent results when properly applied; others, unfortunately, have little effect, sometimes aggravate existing operating problems, photo, right. Suffice it to say that confidence can be placed in reputable suppliers.

Some additives are injected as slurries, others in dry form. Photo, left, shows a typical tank and pump arrangement for slurry injection for smaller-size installations. Larger units generally have pumps fed from sizable, mechanically agitated mixing tanks. Photo, center, illustrates a dry-feed method. One utility reports highly satisfactory results from a calcium-oxide slurry sprayed in by soot blowers.

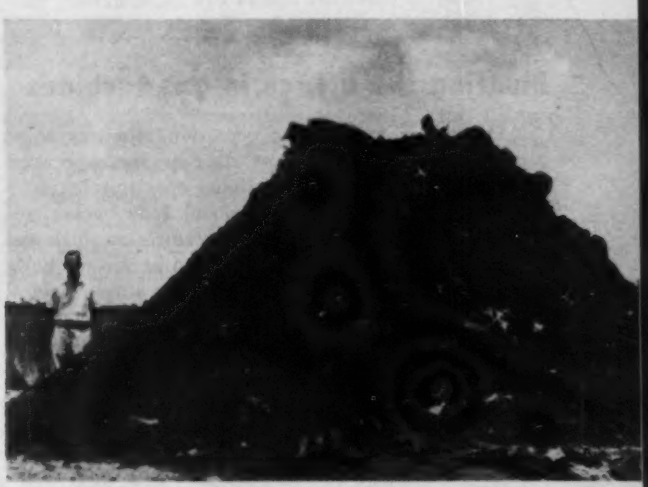
**Low-temperature corrosion,** too, is yielding to additive counterattack. Injected, dry or in slurry form, ahead of "cold-end" equipment, they're effective in reducing acid dew point, cutting acid formation and consequent corrosion. Ammonia, while somewhat trickier to handle, is getting more attention as a low-temperature-corrosion inhibitor. One proprietary treatment appears successful in combating both high- and low-temperature problems and the ammonia-handling difficulty; an ammonia-bearing compound, injected into the furnace, releases the ammonia gas which goes to the low-temperature zone to do its job while its fellow constituents come to grips with high-temperature slagging and corrosion.

In time, considering knowledge gained steadily in use of additives and progress being made in metallurgy, industry will have oil-fired boiler slagging and corrosion problems well in hand.

**continued**



**DRY-ADDITIVE** feed may be preferred. Typical unit shown is automatically feeding dolomite from bag-holding hopper



**DEPOSITS** from half-million lb-per-hr boiler in six months show that some additives' disadvantages offset advantages

## Protection for coal-fired units

In coal-fired boilers as in oil-fired units, high-temperature corrosion and ash deposition are closely related phenomena. While coal ash shows no significant traces of vanadium oxides, it does contain sulfides and complex alkali-iron sulfates. These are corrosive and their attack accelerates greatly when tube-metal temperatures reach or exceed their lowest melting point.

Low-temperature-corrosion causes and effects are similar to those found in oil-fired units with one exception: absence of vanadium and its catalytic action in conversion of sulfur dioxide to sulfur trioxide tends to lessen possibilities of trouble from sulfuric-acid formation. However, this is true only of units which don't use residual oil at all—even for lightoff or as secondary fuel.

**Counterattack** against slagging and corrosion of coal-fired units is basically the same as for oil. Fuel preparation, to remove harmful elements, can be somewhat more effective. But coal cleaning has its economic limits. Best line of defense lies in proper use of effective additives now available. *Proper use* must be stressed if additives are to do a good job. This involves more than mechanics of getting them into the units. Not cure-alls, additives can't offset poor combustion and dirty metal.

Latter probably accounts for much needless corrosion of "cold-end" equipment, particularly during the first 24 hr after a boiler comes off the line. Sulfur-trioxide gas, already absorbed in carbon-bearing soot deposits, meets moisture which triggers the reaction to form sulfuric acid. This acid, itself a powerful dehydrating agent, absorbs more moisture which reacts with more sulfur trioxide, produces more sulfuric acid. Eventually, this vicious cycle slows. As more water vapor condenses, acid dilutes, has less corrosive effect. But by this time it has taken a heavy toll.

**Experts' consensus** is that slagging and corrosion in coal-fired boilers can be effectively combated, in most cases, by methods available today.

## Blunting the attack in gas turbines

Vanadium and sodium corrosion problems aren't confined to boilers or any other specific application of residual fuels. Gas turbines operating on residuals are subject to nozzle and rotor-bucket corrosion. Here, operating temperatures are high and corrosive effect of molten ash can be severe. Early in the game it became apparent that a metallurgical solution would be a long, hard pull. Consequently, urgent need for some relief directed effort toward fuel treatment. As a result, methods are available for modifying residual fuel oil and considerably lessening vanadium and sodium attack.

**Temperature level** can have a bearing on treatment used. Under 1200 F, corrosion isn't severe. Major objective is to reduce total amount of deposits, retain efficiency at high level without resort to frequent outages for cleaning. Above 1200 F, treatment is slanted toward reducing corrosion as well as slag formation and deposits.

Water-washing to remove water-soluble minerals, followed by centrifuging, helps reduce oil's total ash and is frequently used where gas turbines operate at high temperatures. Authorities say this procedure is a must when oil is treated with water-soluble additives such as magnesium sulfate.

Some investigators believe it desirable to increase sodium content in certain cases, giving fuel a higher sodium-to-vanadium ratio. Apparently this increases likelihood of forming water-soluble sodium instead of less-desirable sodium vanadyl vanadate.

**Effective inhibitor** of high-temperature corrosion is magnesium fed as water-soluble magnesium salts. But used in high concentration, these additives in themselves may cause deposition problems. It has been suggested that magnesium be used to inhibit high-temperature corrosion while using materials such as kaolin to control ash deposition.

Kaolin and similar additives are effective in minimizing ash deposits in gas turbines operating below 1200 F. They promote powdery friable deposits which are blown out in exhaust gases.

**Oil-insoluble metal oxides** (aluminum, calcium, magnesium) are effective additives. Blended with oil in concentrated slurry, they're fed to main oil stream. Difficulty is their need for constant agitation to prevent settling and to insure proper dispersal throughout the oil. This generally means complex handing equipment and attention by personnel. On the other hand, oil-soluble additives, though comparatively expensive, are easier to handle and disperse in the fuel. Important factor, regardless of comparable qualities and faults, is that they are within economic reach and are holding the line against vanadium and sodium attack. In the meantime, research continues apace to find even more effective weapons.

## Additives cut diesel problems, too

Any discussion of combustion deposits and corrosion due to burning residual fuels in diesel engines would be repetitious. Vanadium and sodium ash again are the culprits to be countered. Treatment follows the now-familiar pattern: (1) physically removing, within economic limits, the insoluble materials and (2) using additives to offset corrosive effects of the oil-soluble vanadium, sodium and sulfur compounds. As in boilers and gas turbines, reputable additives available today are delivering significant increases in diesel availability.

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By D B HOOVER
Manager, Electrical Section
Large Dc Motor and Generator Engineering
Westinghouse Electric Corp

# Rotating-exciter design keeps pace with generator progress

**New rotating-rectifier excitation system joins commutator machines in meeting demands of today's large generators. Next month we'll look at static exciters**

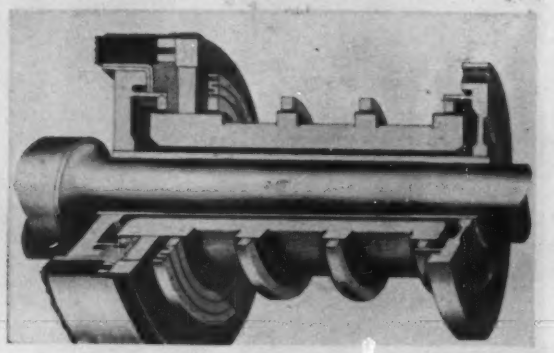
**ROTATING RECTIFIER** mounts on its shaft along with armature of the ac exciter. No current-collector rings or brushes are used

Exciters have kept pace with the amazing strides in design of turbine-driven generators. Present-day excitation requirements of 1450 and 1500 kw for 3600-rpm ac generators rated up to 384,000 kva (max capability at 60-lb hydrogen is 422,000 kva) make it difficult to realize that just eight years ago only 350-kw excitation was required for the largest generator, rated 129,410 kva.

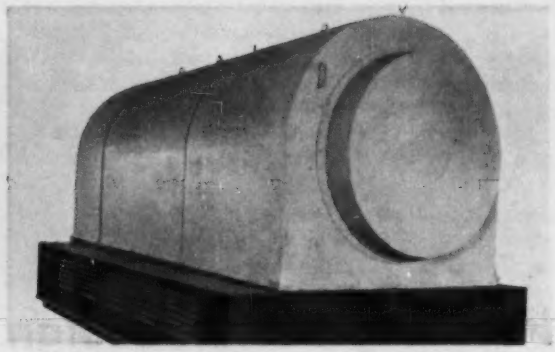
High-speed exciters were developed in the 1930's for direct connection to 3600-rpm turbine-driven generators. Design problems were formidable. For instance, commutators were required for operation at peripheral speeds of approximately 10,000 ft per min. Despite rather wide temperature cycles due to load changes, these commutators had to remain true and balanced within a few thousandths of an in., with bar-to-bar truth better than one ten-thousandth of an in. An important innovation was the free-floating shrink-ring commutator shown in Fig. 1. This construction with its free-floating bars and its thin-disk centering plate permits free-bar expansion and contraction without distortion or eccentricity during temperature changes. It has multiple balancing planes for fine and permanent balance adjustment.

**Ease of inspection** and maintenance is an objective of modern design. Present-day roll-away housing (Fig. 2 and 3) is a good answer to easy commutator access.

As exciter ratings increased, more special design features were applied to increase commutation margin and insure minimum maintenance efficiency. Some of these features include: (1) Special cement packing behind the commutator necks to eliminate creepage paths in this vulnerable area. (2) Use of coil insulation specially developed for maximum heat transfer, resistance to entrance of moisture and dirt, and dielectric strength. (3) Completely taped (mummified) commutating-pole coils, wiring around frame connections and armature cross-connection leads. (4) Rotor-coil extension banding with interlocking ends and hooded insulation. (5) Use of compensating windings and split-throw armature coils on the larger units to provide for transfer of commutating energy. (6) Use of circumferential brush stagger on large-rating exciters to increase



1 High-speed commutator is constructed on *free-floating* principle to remain true and balanced despite temperature cycles



2 Roll-away housing of modern exciter is removed quickly for inspection and maintenance. Ventilation comes through base

## Today's large commutator exciters may be direct-, gear-, or

the time of commutation, reduce the reactance voltage of commutation and to provide increased resistance at the finish of commutation. (7) Brazed joints. (8) Brushholders designed especially for exciters.

These features give exciters a degree of reliability that allows long periods of uninterrupted service between maintenance shutdowns, comparing favorably with those of other components in the generating unit. Normally the only maintenance required on exciters between down periods required for other equipment is the replacement of brushes and cleaning of air filters.

**Brush work** is often done on the exciter while it is carrying normal load and is at full excitation voltage; therefore the design must permit this work with minimum risk to operator and equipment. The commutator area is kept open and free from obstructions, Fig. 3. Brushholders designed with wing nut permit easy removal and replacement of brushes by the operator using no tools. A spring retainer at center of pressure plate clamps two brush shunts, permitting removal of one shunt without the other escaping from locking pin.

**Large exciters** have design considerations—peripheral speed of the commutator and resulting brush wear and maintenance, reactance voltage of commutation, desirable limits of rpm × kv—indicating that ratings in excess of about 350 kw are difficult to justify at 3600 rpm.

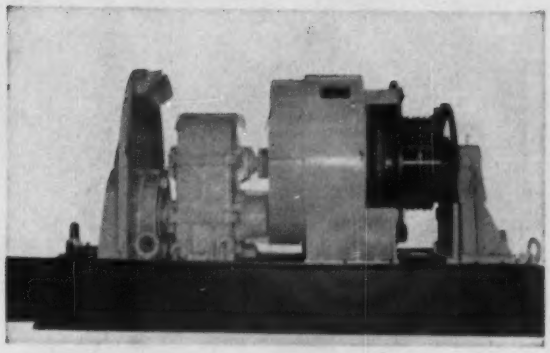
The need for larger and larger exciters led to development of motor-generator-set exciters incorporating desirable and proved special features of the direct-connected exciter. These units were designed to take full advantage of the lower speeds for low commutator peripheral speeds and reduced brush maintenance. In recent years there have been many motor-generator sets sold for main-exciter applications. These sets are equipped with flywheels to provide operation comparable to the direct-connected main exciter during faults affecting the driving-motor power source. Size of motor-generator sets has grown steadily and now reaches 1500 kw at 514 rpm. One application requires a 3-unit set with two main exciters, each one rated 950 kw at 885 rpm. One unit excites the high-pressure, other the low-pressure turbine-generator.

Housing for a large flywheel set is shown in Fig. 4. In this construction, equipment is sized to let operator walk into the housing to inspect and maintain the unit. Ventilating air is taken in through filters at end of housing, discharged into room at the side. Inside of housing is coated with sound-absorbing material.

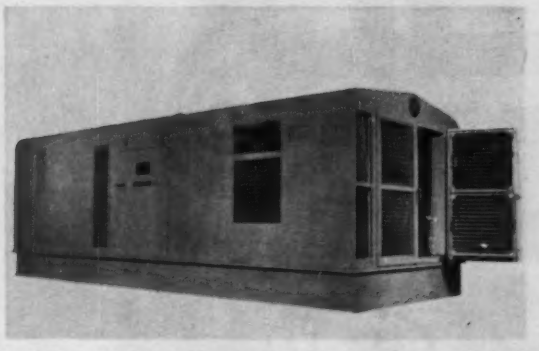
**Geared** direct-connected exciters are available to permit main-turbine drive with the advantages of lower speed dc armatures. Geared exciters have proved completely reliable and have been widely accepted (Fig. 3 shows a 300-kw unit). Units have been built rated 1450 kw at 514 rpm.

**Trends** based on past records indicate that for ratings below 250 kw, the direct-connected 3600-rpm exciter remains the undisputed leader. Demand of electric utilities for geared direct-connected and motor-generator-set exciters for units above this rating keeps growing, and the movement to larger and larger ratings continues. Last few years show about an even split between large geared exciters and large m-g-set exciters.

Synchronous condensers and waterwheel generators also need exciters. Synchronous condensers usually operate at speeds ranging from 600 to 900 rpm; problems of direct-connected exciters under these conditions are less critical than those of steam-driven units. These exciters often overhang the condenser shaft. Some units are included in the hydrogen cooling systems of the main unit to reduce required shaft sealing. Hy-



**3** Geared exciter, housing removed, is 300-kw unit. Gearing permits main-turbine drive with lower commutator speeds



**4** Motor-generator set housing permits operator to walk in for inspection and maintenance. This is a large flywheel exciter

## motor-driven units

drogen atmosphere has the added advantage of reducing brush wear.

Water-wheel generators usually operate at slower speeds than turbine generators. As a result, exciters are physically large, generally direct driven. Problems of brush wear and maintenance on these exciters are very minor and except for mechanical features required for the vertical construction, these exciters can use standard machine features.

**Future exciters** for turbine-driven generators will probably be rotating-rectifier excitation systems. Such a system, developed by Westinghouse, is expected to be in operation early this year. System eliminates brushes, commutator and collector rings. A rotating rectifier is mounted on the same shaft as the ac turbine-generator field. Ac exciter's rotating-armature output is fed along the shaft of the rotating rectifier. Rectifier's output, in turn, is fed to the field of the ac turbine-generator. A magnetic-amplifier regulator, acting on the field of the ac exciter, controls strength of the ac turbine-generator field. Thus, no current-collecting brushes are required, and conventional ac - generator - field collector rings and dc-exciter commutator are eliminated in this design.

The ac exciter is a proved design with a rotating armature and a stationary field. It generates 420-cycle 3-phase power which is fed to the rectifier. Exciter may be separately excited from a motor-generator set or excited by a shaft-mounted permanent-magnet ac pilot exciter. In this case output is fed first to the regulator and then to ac-exciter field.

Rotating rectifier is made up of silicon diodes. Diodes are arranged for desired dc output to meet requirements of the ac turbine-generator field. Sufficient capacity is provided so that diodes won't be overloaded, even though approximately 30% of each phase is out of service. Fuses protect the rectifier elements.

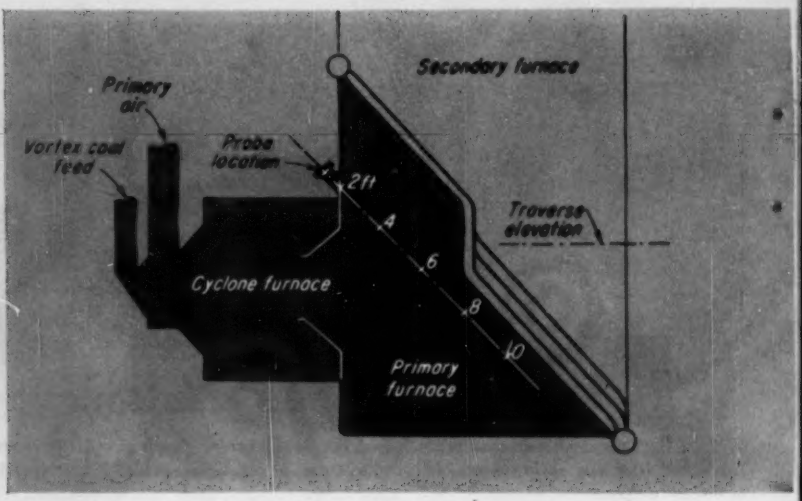
### This system takes power from stator

A new method of obtaining generator excitation, through a separate winding placed in the top of the generator stator slots, was described at the Winter General Meeting of the American Institute of Electrical Engineers. Authors of "Test report on harmonic excitation of ac generators" (No. CP60-226) are F I Biggs and P I Nippes of the Elliott Company, Ridgway, Pa.

Generator used in the experiment was an 11,500-kw 3-phase 13.8-kv 3600-rpm air-cooled unit at 0.8 power factor. Excitation required for conditions of rated load, voltage and pf was 47 kw; for no-load rated voltage, excitation was 9 kw. Leads from the auxiliary winding were brought outside the machine and the output was fed into a full-wave bridge silicon rectifier. Voltage generated in the auxiliary winding contained no fundamental (60-cycle) frequency, but was composed of third harmonics of the fundamental plus a small quantity of other odd harmonics not cancelled by the winding arrangements in the slots of the stator.

The paper pointed out that such harmonic-frequency power is not limited to excitation, but could serve as a source of high-frequency power for various plant auxiliaries.

**$O_2$ RECORDERS** in control room supply operator with continuous check of combustion conditions




**PROBE LOCATION** was decided on basis of test traverses in primary and secondary furnaces. Data from 1-ft intervals supplied flow profile at cyclones

# Cyclone $O_2$ analysis checks combustion

## United Illuminating Co's continuous $O_2$ analysis at each cyclone maintains precise combustion control under changing conditions

Monitoring combustion efficiency by means of continuous $O_2$ analysis is not new, and there are several units operating with $O_2$ analyzers tied to combustion control. But our system, developed as a cooperative effort of our engineers and manufacturers of the $O_2$ analyzer-sampler system, answers need for precise measurement of actual combustion efficiency for each cyclone. Armed with a dependable, accurate measurement of combustion at each burner, we automatically maintain correct fuel-air ratio regardless of fuel variations or other factors.

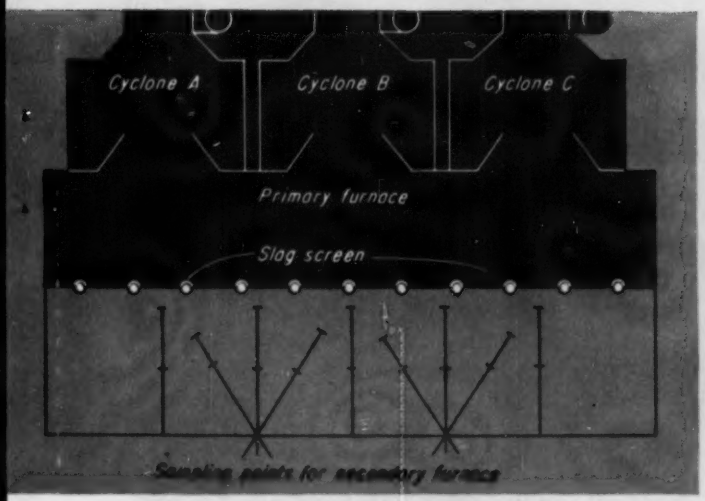
Design and installation of an $O_2$-analyzing system varies for each furnace design, cyclone arrangement, slagging condition, etc. Since equipment supplier and we ourselves had limited experience with this problem, we agreed on a program of test and evaluation to determine equipment design and sampling techniques required for our operation. If you are thinking of $O_2$ analyzers for your unit, a description of our test program may help in setting up your own test and evaluation plans.

**Our system** is installed on a Babcock and Wilcox steam generator, fired by three cyclone furnaces and producing 625,000 lb per hr of steam at 1500 psig. The three cyclone furnaces are placed side by side across the furnace frontwall, see plan view above, and are fed in the conventional manner by individual fuel and air supplies. Because fuel and air for each cyclone are controlled by a separate system we can bias the basic fuel-air ratio to correct for possible unbalances. Conventional control depends on balancing fuel feed rate against differential of flow orifice mounted in the cyclone air duct. Actual fuel-air ratio varies with changes in coal chemistry and deviations in cyclone-air temperature. Obviously, a dependable, direct measurement of combustion efficiency permits compensation for deviations.

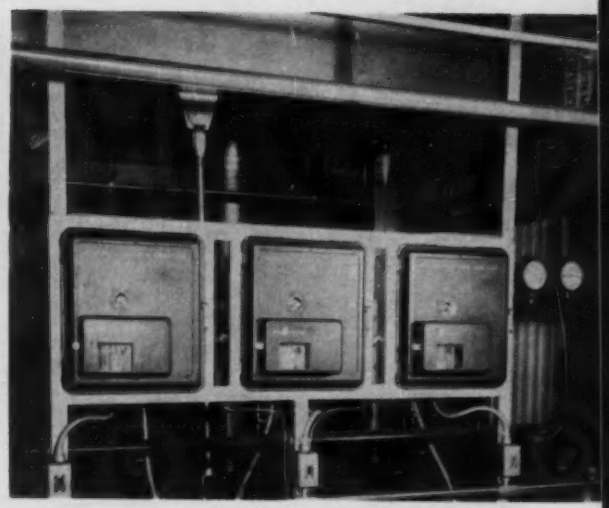
**First attempts** at combustion monitoring followed standard practice by placing three oxygen-sampling probes through furnace rearwall ports, see elevation view above. This particular location had two disadvantages as far as our unit was concerned: (1) Probe maintenance was high because of slag falling from furnace walls. (2) General turbulence of flue gas leaving cyclones, plus balancing effect of screen tubes between primary and secondary furnace, made probes insensitive to changes in combustion efficiency for one particular cyclone.

**Trial location** aimed at correction of both initial problems. We decided to investigate practicality of sampling at cyclone outlets. Our initial trial was on one cyclone, and resulted in a system we could apply with complete confidence to all three.

Probe design led to our success. To have a workable system we would




**CYCLONE UNBALANCE**, deliberately set up for test purposes, was accurately measured by cyclone probes, missed by secondary probes



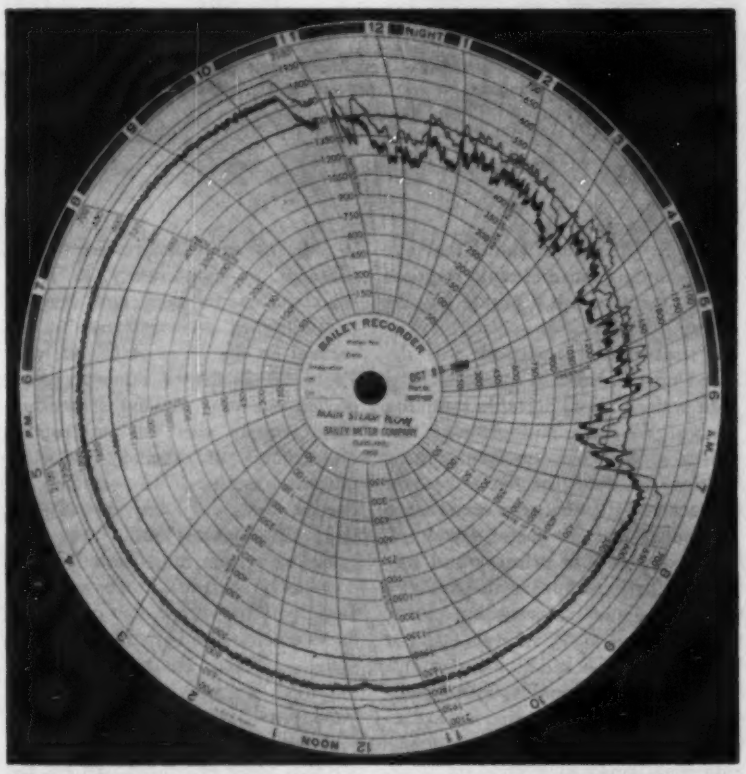
**ANALYZER UNITS** mount near probe location for easy maintenance of system. High sampling rate speeds reaction

# efficiency

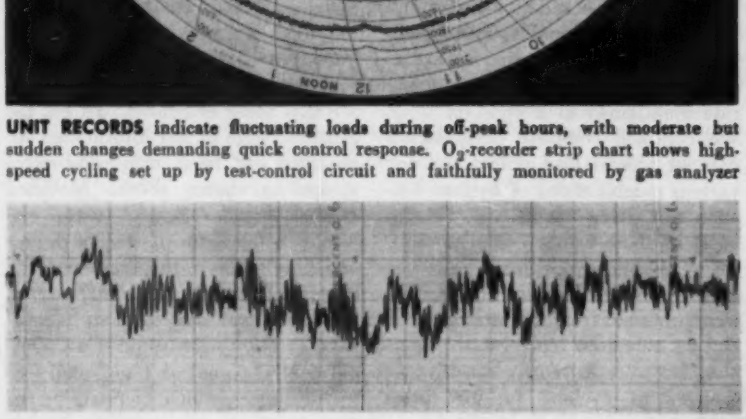
By J J OSOCHOWSKY, Results Engineer and E A SCHEMPP, Combustion Control Technician
United Illuminating Company
Bridgeport, Conn.

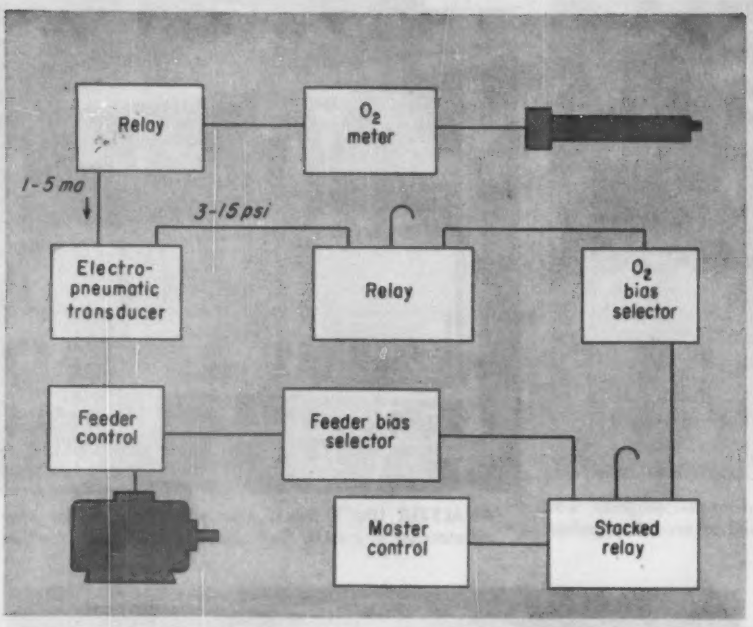
have to keep the probes alive in 3000-F gas temperatures, keep them from plugging up with slag and locate each probe so that sample reflected actual cyclone conditions over the entire load range. Problems of probe life and slag plugging were solved by Leeds and Northrup engineers who developed our original system. Our new-design water-cooled water-flushed probe withstands 3200-F gas. We can keep water-washed sample nozzle clean on a continual-operation basis, without extensive servicing.

**We installed** three separate paramagnetic $O_2$-analyzer systems with steam-jet condensers and cyclone separators to scrub gas sample and remove water, acid and dirt particles. Analyzers, above right, mount near cyclone fronts to ease servicing of probe-analyzer system. Generator unit rides with system-load swings during off-peak hours, so rapid load changes of the sort shown at right require high-speed analyzer




**UNIT RECORDS** indicate fluctuating loads during off-peak hours, with moderate but sudden changes demanding quick control response. $O_2$-recorder strip chart shows high-speed cycling set up by test-control circuit and faithfully monitored by gas analyzer






**CONTROL SYSTEM** contains multiple-element trimming loop activated by $O_2$ analyzer. Added relays permit variations for test purposes in $O_2$ signal's effect on fuel feed

response. Strip chart shows that our high sampling rate and rapid response of analyzers permit accurate logging of rapid load swings.

**Final probe location** was decided on the basis of extensive tests with water-cooled, portable sampling probes. We made multiple-point traverses of each cyclone throat, three original locations in the secondary furnace and duct between economizer gas outlet and air-heater gas inlet. Traverse points in primary and secondary furnaces appear in plan and elevation views on preceding pages.

In addition to $O_2$ analysis at three locations, we checked all primary and secondary furnace points with a combustibles analyzer. During each test, boiler was base loaded and firing rate maintained at a constant level. We collected complete performance data at several load points and for various combinations of cyclone balance and firing conditions. On the basis of these rather complete tests, we were able to position a probe at each cyclone outlet so that probes were protected from major slag drops and not only drew representative samples, but were extremely sensitive to changes in cyclone fuel-air ratio.

**Operation** of the revised system afforded an opportunity to check maintenance estimates and evaluate possibility of automatic combustion control on the basis of $O_2$ analysis. Probe life in 3000-F atmosphere exceeded one year as long as cooling-water supply was not interrupted. Maintenance of other system components was limited to periodic calibration checks of analyzer and servicing of separator unit. Any gas-sampling system must battle erosion created by entrained ash particles. Design of our separator system reduces erosion to a bare minimum and places affected components where they can be serviced or replaced quickly and inexpensively.

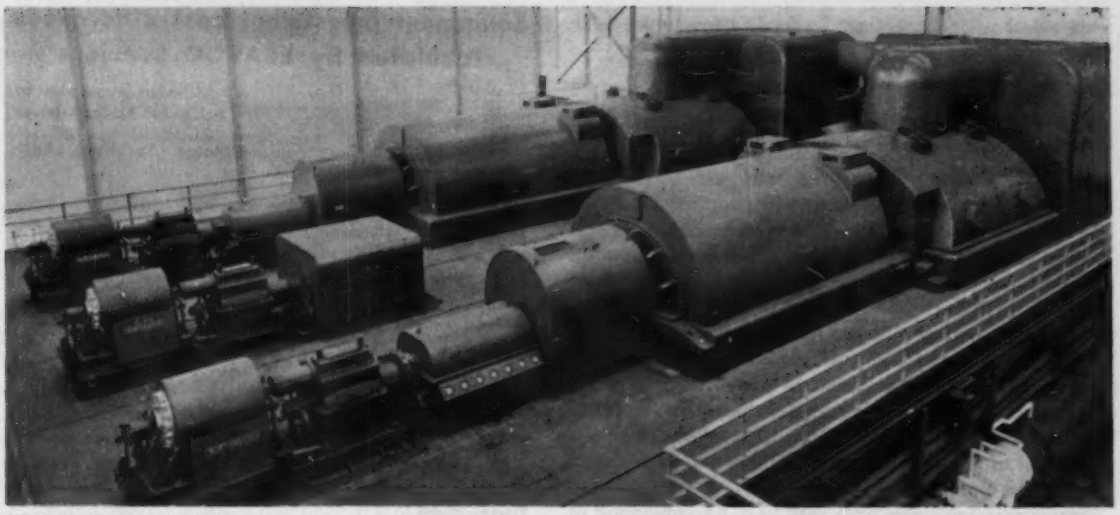
**Automatic-control** possibilities are still being evaluated. To get the greatest range of test information we modified our basic coal-feed-control system as shown above. Modified system includes several extra elements in the form of stacked relays and bias selectors to permit varying degree of control $O_2$ signal exerts.

Basic signal sent to chart recorders also goes to electronic relay. Output control signal of 1 to 5 ma goes to transducer which converts signal to 3- to 15-psig pneumatic impulse. Air signal goes to relay whose output passes through the auto-manual bias selector and on to a final stacked relay. Master fuel control signal also comes to this relay, and $O_2$ control signal is stepped down so that an 8-lb change in impulse from bias selector results in 1-lb change in output of stacked relay. Under these conditions, $O_2$ control acts as a limited trimmer to bias impulse from master fuel control by a maximum of 12% of full range.

Although this control network contains too many components to fulfill requirements of a final system, relays' inherent flexibility permits us to vary effect of $O_2$ signal from 0 to 100% of fuel drive range. Present limited control function can create a cycling action of the type shown in strip chart on the preceding page. This is strictly a result of two control signals, each designed to handle total control, operating concurrently on the fuel-feeder drive. This control duality would not exist in a final system.

**What have we learned** from our tests and operating records? That our present system of individual $O_2$ analyzers and probes mounted at each cyclone supplies dependable, accurate operating data without imposing a maintenance burden on plant personnel. As a high-speed monitor of cyclone combustion, analyzers offer us a further safety feature. Flame-failure monitors at each cyclone signal flameout, but $O_2$ analyzers pick up poor combustion conditions as well as the sudden increase in $O_2$ as ignition fails. Anticipating action of the analyzer gives operators a little extra warning of trouble, often enough to prevent major upsets.

For automatic combustion control, $O_2$ control probably will remain a trimmer of basic fuel-air ratio for each cyclone. However, all our test data indicate $O_2$ control could safely operate as a full-range fuel-feed adjustment. Our final step in development of $O_2$ control would logically entail selection of components which best link analyzer output to fuel-feed control. Selection is complicated only by the need to marry analyzers' electrical output to requirements of a pneumatic combustion-control system. The wealth of operating data we have collected will greatly simplify this selection.



**HIGH-SPEED FEED PUMPS** driven through hydraulic couplings and gears at Public Service Electric and Gas Co's Bergen Station

**Consultant and manufacturers agree:**

# Generator-driven boiler-feed pumps for large stations are here to stay

## Using generator drive can save big money in large units, but detailed evaluation must prove out each and every case

It is a rare occurrence when three experts with diverse opinions discuss a controversial subject in the same room at the same time. But that happened here in New York recently when turbine-generator-driven boiler-feed pumps for large units were discussed by M W Larinoff of EBASCO Services, I J Karassik of Worthington Corporation and R D O'Neil of American-Standard Industrial Div. And now each participant in this lively meeting presents his ideas.

### Mike Larinoff says:

Boiler-feed pumps and their many drive arrangements offer interesting investment savings in the larger sizes.

In studying the three basic drive arrangements, motor, turbine and generator (*Feed-pump drives—have you checked them all?*, POWER, Dec 1959, pp 94-95), we must be sure that all alternates are consistent in their degree of standby, startup, safety and remote operation. We must try to avoid the "apples and oranges" comparison—and if such comparisons are made, the differences must be clearly spelled out so their advantages and disadvantages can be resolved by judgment.

Having set forth alternate cases to be studied, we can proceed with the economic evaluation. But be careful to maintain comparable investment costs. Here there are two approaches: (1) A design which produces the same net kw at the step-up transformer and (2) a design which offers incremental kw through use of certain drivers. *Both* approaches must be evaluated. Quoted equipment prices and actual equipment layout must be studied to ascertain true investment differences. Table on next page shows how costs may compare (assume 1 is base) when examining a typical design producing the same net kw to the system—for example, a single 100%-capacity pump arrangement in a 200- to 300-mw central-station unit.

Let's look at the present popularity of these three basic drivers. Bear in mind that the mechanical-drive turbine and the generator-shaft drive are comparatively new drivers which are of interest primarily in large-size high-pressure installations (usually of over 200 mw).

The three major turbine-generator manufacturers were polled recently and reported their total installations and units on order up to the present time:

| | Shipped | On order | Total |
|---|---|---|---|
| Mechanical-drive turbines | 16 | 20 | 36 |
| Generator-shaft drives | 6 | 14 | 20 |

EBASCO recently ran a survey of its own: 85 utilities

were asked to indicate their preference for future feed-pump drives; 54 utilities answered as follows:

| | Number | Percent |
|---|---|---|
| Motors | 40 | 74 |
| Mechanical-drive turbines | 8 | 15 |
| Generator-shaft drives | 6 | 11 |

We believe that motor drive will continue to be the most-popular arrangement for average 200-mw and smaller subcritical units. Where two half-capacity pumps are used, the popularity of motor drive should continue even above 200 mw.

If the installation is larger than 200 mw, especially if a single full-capacity pump is used, generator-shaft drive and steam-turbine drive should be investigated for some interesting savings. Both generator-shaft and steam-turbine drive should be analyzed on basis of the same net kw output to the system. Otherwise, value of incremental kw becomes a problem to handle.

Supercritical-pressure units may have a combination of motor drive for booster pumps and either shaft or steam-turbine drive for the main pumps. Smaller-size high-speed pumps are practically a must here.

As 3600-rpm cross-compound turbine generators become more common, generator-shaft-driven boiler-feed pumps probably also will see increased use. This turbine-generator design permits the popular two-half-capacity-pump arrangement. Simplicity of main shaft drive has great appeal and for the larger-size units permits investment savings compared to either motor or steam-turbine driver.

There is probably no other design item in a large-turbine-generator installation offering more opportunity for alternative design arrangements than the boiler-feed pump and its driver. The "heart" of the steam-power plant has captured the imagination of many engineers both in the power-plant field and manufacturing. It should be treated with tender care and consideration.

## Igor Karassik says:

The boiler-feed pump has become such an increasingly important item; similarly so must it be with the means used to drive it. And it is possibly because of this importance that the choice of the boiler-feed-pump drive has become as controversial a subject as it is.

Today, a most dramatic development is taking place —the use of the main turbogenerator to drive the boiler-feed pumps. It may be too early to pass judgment on the ultimate future of this development, but as of today my company has shipped or is producing a total of 16 pumps to be driven from the main generator shaft and to be installed in 11 units for a total rating of over 3,000,000 kw. All indications point to the probability that this will become a very popular arrangement for units of 175,000 kw and larger.

Most papers presented on boiler-feed-pump drives appear to be directed at proving that this or that method is the most-economical or most-efficient solution. It seems to me, however, that we should first bend our efforts to establish certain logical ground rules which will permit us to make equitable comparisons between the various methods. It is not my intention, therefore, to add further fuel to this controversy at this moment, but rather to review the broad phases of the problem faced by the power-plant designer in his choice of drive and to indicate, again in very broad terms, a few of the various factors which affect this problem.

We should note that, in the major essentials, the boiler-feed pump does not particularly "care" what sort of a driver will put it in motion—be it electric motor, steam turbine or main generator. But, of course, pump maintenance will always benefit from variable-speed operation. And a pump will be more reliable if it operates at high speed; it will have fewer stages, a shorter shaft span, a lower shaft deflection and more margin against accidental contact at the running joints. Since either the electric motor or the main generator can be supplemented by a variable-speed device and a step-up gear, these advantages can be had regardless of the basic type of drive selected.

Here I must introduce a general consideration of engineering methods. Much as an engineer may dislike reaching such a conclusion, we must admit to ourselves that personal preferences and habits will play as important a part in our decisions as the imposing array of numbers and calculations with which we bolster the validity of these decisions in the reports we prepare in their justification. But we need not necessarily feel ashamed of this fact, as long as these preferences are not based on prejudice and the habits are not clothed in ignorance. It may well be said that in the area of steam-power-plant design, engineering is not an exact science and a blind substitution of numbers into handbook equations cannot take the place of sound judgment and experience.

When we sum up all the advantages and disadvantages that can be marshalled for each type of drive, we find

## Equipment investment cost differences tabulated by EBASCO Services

| Major equipment | Additional investment for boiler-feed-pump driver: Motor | Turbine | Shaft |
|---|---|---|---|
| B-f pumps & spare rotor assembly | 1+ | 1 | 1+ |
| Booster pump (where used) | 1 | 1+ | 1+ |
| Main motor driver & electrical | 1 | 0 | 0 |
| Booster motor driver & electrical | 0 | 1 | 0 |
| Mechanical-drive steam turbine | 0 | 1 | 0 |
| Disconnect coupling | 0 | 0 | 1 |
| Main turbine (basic) | 1+ | 1 | 1+ |
| Main turbine (extra) | 1 | 1+ | 1 |
| Main generator (kva) | 1+ | 1 | 1 |
| Boiler | 1 | 1+ | 1 |
| Piping—boiler feed | 1 | 1+ | 1+ |
| Piping—feedwater heating extraction steam | 1+ | 1 | 1+ |
| Piping—steam | 1 | 1+ | 1 |
| Hydraulic coupling | 1 | 0 | 1+ |
| Auxiliary transformer | 1+ | 1 | 1 |
| Motor-driven exciter controls and wiring | 1 | 1 | 1+ |
| Turbine-generator pedestal | 1 | 1 | 1+ |
| Monorail and hoists | 1+ | 1+ | 1 |

that the power-plant designer will generally wish to conduct an economic evaluation of the possible choices. And here, I believe, is where much of our difficulty arises. When all the factors and costs have been tabulated, we find that the advantage of any one solution over another is represented by the difference between two very large numbers and that this difference is an extremely small percentage of the numbers themselves.

Then, if the error introduced by various approximating assumptions is of the same order of magnitude as the difference between these numbers, the advantage of a given solution may easily disappear and become converted into a disadvantage merely through a slight shift in the assumptions.

How are such errors introduced? Some of the components of these large numbers are "real" values, as for instance the cost of the various pieces of equipment involved. Other components, on the other hand, are made up of values assigned somewhat arbitrarily to such factors as "availability."

Thus, it seems to me that variations in the assumptions made in arriving at the values of these large numbers in our evaluation tabulations can be equal to or greater than the final differences which are intended to guide our decisions. We should not eliminate the evaluation process. But, in my opinion, there is no substitute for experience and sound judgment to temper and "evaluate" our evaluations.

It is true that when we deal with very large units—300, 450 or 600 mw—the very size of the required driver helps us to eliminate some of the solutions without too much soul searching. Certainly, motors of 10,000 to 25,000 hp would be rather difficult to visualize or to justify as boiler-feed-pump drives when other sources of power are available. Thus, while motor-driven pumps may continue to be popular for some time to come in units of 200 mw and below, the inescapable growth in the average size of the main units cannot fail to bring the turbine-driven and the main-shaft-driven boiler-feed pumps into first-place prominence.

## Dick O'Neil says:

A look over the years at boiler-feed pumps and their drivers resembles a foot race. The feed pump pulls ahead and the driving equipment must catch up. They run even for a while but soon the pumps pull ahead again. Present phase of this race started in about 1954 when demands for 4000 to 7000 hp and 3600 rpm put the drivers again in the position of catching up.

The power-plant designer, facing ever-increasing pumping requirements, is constantly looking for a better way to drive high-pressure boiler-feed pumps. This search has led him to main-generator drive. He can now eliminate large-horsepower high-speed motors with their accompanying switchgear and increased transformer demands; he can eliminate one step in energy conversion; he can use the characteristics of a variable-speed drive for both power transmission and equipment protection.

There are 26 hydraulic couplings currently running or being built for generator drive (in addition there are two eddy-current variable-speed units and one unit is being built with no variable-speed device between the boiler-feed pump and generator). These are for 17 turbine-generator units. Of these, 8 have full-capacity pumps and 9 are arranged for half-capacity pumps. Of the 26 pumps involved, 16 are 3500 rpm and 10 are high speed.

Principles and operation of these generator-drive hydraulic couplings are the same as the hundreds of motor-driven units in use throughout the country. Certain design differences, however, have been necessary to successfully mate a boiler-feed pump and a turbine-generator.

Shaft-driven hydraulic couplings are designed to match the center line of the main generator, and all coolers, oil pumps and filters are located below the floor for appearance sake. Input bearings must be designed to take the added thrust imposed by expansion of the generator shaft. A magnetic-holding brake is provided on the output shaft of the hydraulic coupling so feed pump can be brought to rest for inspection without interrupting turbine-generator output.

First shaft-driven hydraulic coupling has been in service over a year—later units for over six months. The only difficulties experienced involved auxiliaries.

A very interesting application for which hydraulic couplings are currently being built is a subcritical once-through-boiler unit providing variable-throttle-pressure steam to the main turbine. Here the hydraulic couplings will have an operating-speed range of 55 to 100%—considerably greater than in a constant-throttle-pressure unit.

This is the path, then, that main-shaft hydraulic-coupling-driven boiler-feed pumps have taken in the relatively short period of six years. Largest units to date are 12,000 hp, but there are no particular hp limitations. With pumps of 20,000 to 25,000 hp available, it is understandable that studies are being made for shaft-driven hydraulic couplings in this higher range.

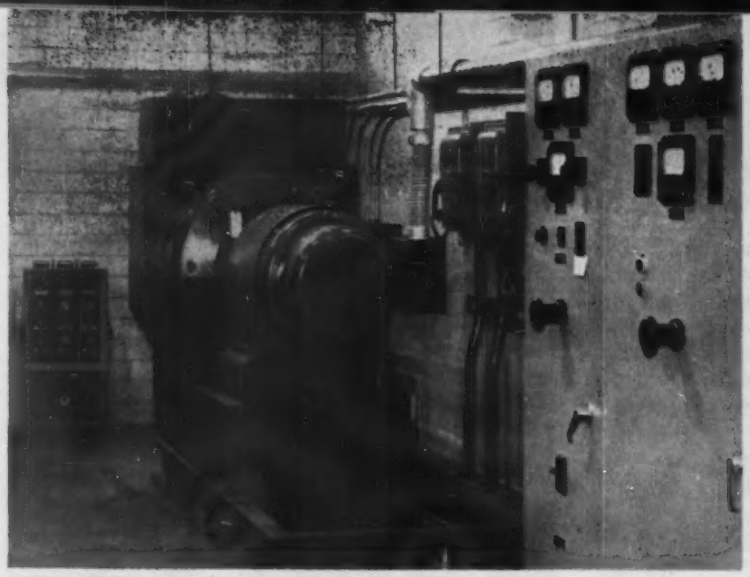
## Incremental kw—what are they worth?

In considering various boiler-feed-pump drives, there will be differences in kw available to system—incremental kw—to be evaluated. What are they worth?

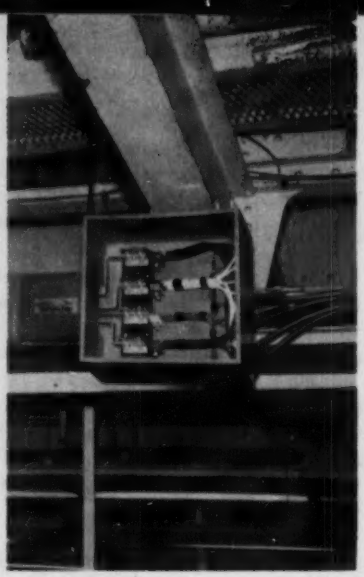
There are many ways to gain kw increments. Small amounts may sometimes be purchased at low cost merely by adding surface to the condenser. A few more kw can be had at slightly higher cost by opening up the front end of the turbine and absorbing all surge margins in boiler, pumps and heaters. More yet are available at considerable cost by increasing the size of all power-plant elements. As the increment of power gained becomes larger, added cost per kw of this increased capacity rises.

But what are they worth? Can they be sold as such? Will they defer installation of the next unit in the system? Could they be purchased from a neighboring utility at the same time that annual peak loads are encountered?

**All three experts agree:** These questions—and actual worth of kw increments—can only be answered by the particular utility involved, knowing system loads, capabilities and neighboring utility connections.



**NOISE SUPPRESSOR** is built into converter m-g set. Remote location of converter, such as in transformer room, further reduces objectionable high-frequency noise in work areas



**CABLE** has three neutral wires intercalated between phase wires for low reactance

**Power at frequencies above 60 cps is used more and more in industry. Experience in developing a 400-cps system of over 1500 kva points out problems, possible solutions in . . .**

# Medium-frequency distribution

By EDWARD J GROGAN JR, Sperry Gyroscope Co, Div of Sperry Rand Corp*

Use of 400-cycle power developed during World War II on applications to radar and fire-control systems. It gave an improved electrical characteristic for the operation of electronic systems, permitted design of electrical apparatus with lower weight-output ratios. Original installations, although of limited capacity, proved their worth and a gradual conversion to 400-cycle applications was begun by the electronic and aircraft industries. (Industrial uses of frequencies above 60 cycles were listed in POWER's special report, *Electrical Conversion*, December 1959.)

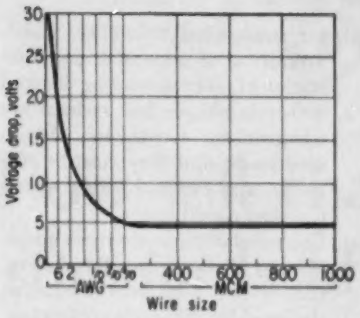
Because of limited demands of the earlier systems, overall problems associated with 400-cycle distribution and generation were not given sufficient engineering evaluation. Adequate line characteristics could then be obtained by locating the generating apparatus so very short distribution systems were practical. In other early installations limited-capacity distribution was possible for reasonable distances by the application of "brute-force" 60-cycle methods. But as the state of the art developed, these earlier attempts to control distribution and generation proved impractical and inadequate.

Present trend toward relatively large-capacity, finely regulated low-harmonic and quick-response 400-cycle systems has necessitated development of new methods and techniques having little resemblance to 60-cycle-system installations.

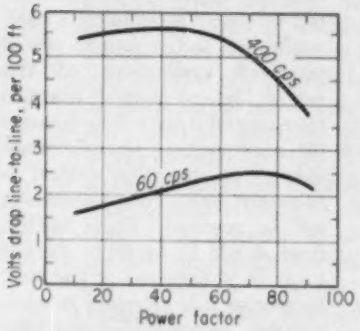
**Distribution.** When unit sizes were of relatively small generator-output capacity (5 to 20 kva), only minor problems came up when apparatus was located adjacent to load area. However, as demands increased so that unit capacities of 100 kva and up were common, it was not always possible to install the generating facility in the most advantageous spot. Other factors—sufficient 60-cycle capacity for large-motor operation and elimination of objectionable generator noise—often dictated that unit be remote from load. And the formidable problem of adequate distribution for 400-cycle power was created.

Plant engineer facing the problem of 400-cycle-system design must alter his approach from traditional design procedures of 60-cycle systems. For the higher-frequency installations, skin effect, proximity effect, conductor spacing and overall system inductance are some of the more-important governing factors. Consideration must be given to and allowances made for characteristics of the load to be sup-

*E J Grogan, PE, is Supt of Electric Power Engineering at the Great Neck, N.Y. plant




**VOLTS-DROP** characteristic curve for multiple conductors at 10,000 amp-ft is typical




**LOW-IMPEDANCE** bus shows different behavior for 60, 400 cps through pf range

plied. In general, each 400-cycle system must be considered as an *overall reactive problem* and all factors taken into consideration if precise end-of-line characteristics are to be realized.

Bus systems utilizing the recently developed 400-cycle bus duct have simplified distribution problems in many plants. Products tested by us gave satisfactory results within their application range. However, the plant engineer must not expect these bus systems to be a cure-all for his distribution problems.

**Overall reactive** characteristics of the generator - distribution - load system must be thoroughly evaluated before you can correctly apply bus distribution. Voltage - drop curves shown above illustrate the variations due to inductance, system power factor or both.

The 60-cycle power is approximately linear over a wide power-factor range and observation shows that system regulation is not an application limitation. However, when the same bus is used for 400-cycle distribution, voltage - drop characteristics are entirely different and more critical. For comparison purposes our plant rating of this bus at low voltage and 1.0% regulation per 100 ft would be 200 amp per phase at 60 cycles but only 85 amp per phase at 400 cycles. Traditional method of sizing distribution bus by its rated current-carrying capacity can lead to unsatisfactory results when precise regulation of low- or variable-power-factor loads is required. A bus system must be applied to the system inductive characteristics, otherwise only unsatisfactory end-of-line characteristics will result. Manufacturers of bus equipment have available characteristic curves for the entire range of their product line. Use these to find particular size required for the specific end-of-line results you want.

**Multiple - conductor** cable systems are practical, and sometimes economical, to design and install. However, to intelligently discuss this distribution method it is necessary to review the adverse line-impedance condition set up by the higher-frequency power.

Impedance of any conductor is determined by fundamental formula:

$$Z = \sqrt{R^2 + X_2^2} \qquad (1)$$

where $Z$ = impedance, ohms
$R$ = resistance, ohms
$X_2$ = reactance, ohms

Reactance $X_2$ at 400 cps can be computed from formula:

$$X_2 = 0.352 \times \log_{10} \times S\,G, \text{ ohms/1000 ft/conductor} \qquad (2)$$

where $S$ = geometric mean distance between conductors
$G$ = self-geometric mean distance per conductor = $0.42\sqrt{C}$
$C$ = area, circular inches

Solution of the above relationships will determine magnitude and angle of the line impedance. When substituted in the 3-phase line-drop formula it will give a good approximation of losses to be expected under any set of distribution-line conditions.

$$V = 1.73 \times I\,Z \times \cos(\psi - \theta) \qquad (3)$$

where $V$ = line voltage drop
$I$ = line current
$Z$ = impedance, ohms
$\theta$ = power-factor angle
$\psi$ = impedance angle

These formulas for the range of commercial conductor sizes show that line reactance has a major effect on line impedance and voltage drop. As cable size increases so does the reactive component, until in the range of 1/0 to 1000 MCM reactance greatly exceeds resistance. Inductance for cables in this range is substantially constant and reactances are large. Consequently, negligible improvement in voltage-drop characteristics would be realized by increasing the wire size. Voltage-drop curve shown, upper left, best illustrates reactive effect on the larger-sized conductors. At the same capacity there is only a 2½-volt drop differential between 1/0 and 1000 MCM for an increase in conductor area of almost 1000%. This establishes the fact that conductor capacity is not a function of its area and an increase in conductor size will have little effect on line impedance.

Slope of the curve for size No. 2 and smaller is much greater and voltage drop at a constant load for the different-sized conductors is more linear. This difference is attributed to a more-favorable resistance - reactance ratio of the smaller cables for higher-frequency conduction.

**To minimize voltage drop,** line impedance must be kept as low as is economically justifiable. One or all of the following procedures may be necessary:

1. All cables must be grouped for minimum distance between phase conductors and all three phases in one jacket
2. Larger capacity, lower impedance or both is achieved by paralleling phase conductors. Conductor size and number of parallels is determined by system requirements and economic cost evaluation
3. Nonmagnetic armor and conduit should be used on systems where close tolerance is required
4. Distribution should be at as high voltage as practical. This is especially important on long distribution lines where installation

## Conversion equipment is part of system design

costs for fine regulation could easily exceed the cost of stepdown transformers

A well-designed 400-cycle system can maintain regulation within 1% —but you must consider peculiarities of higher-frequency distribution to avoid embarrassing consequences.

Comparison of bus and cable systems points up a definite need for both, and engineers should become thoroughly familiar with each. For low-voltage-area distribution the bus installation is superior. From an economic standpoint it is more expensive but still competitive. Cable installations are more adaptable to higher-voltage feeder systems and less costly for the same degree of regulation. Most large-capacity 400-cycle systems will require both types of installations, especially if long distribution lines are required.

**Generation.** Problems associated with application of generating apparatus to 400-cycle systems can be just as critical as the distribution problems. Quality of generator specified depends on type of load to be supplied. Low-power-factor and pulsing-electronic loads necessitate quick response and balanced units while the high-power continuous loads can be supplied by generators built to less-stringent requirements.

Plant engineers should be particularly careful in the development of unit specifications. Overall system adaptability to inductive loads depends directly on the generator quality so the utmost attention should be given to selecting this apparatus. A well-designed well-regulated low-impedance generator with a good fundamental wave form tends to compensate for interferences caused by distribution system or load.

On the other hand, generators with high internal impedances can become inoperative because of low power factor, load harmonics, voltage unbalances and other adverse conditions experienced on all distribution systems. During the testing of one of our earlier large-capacity 400-cycle systems we measured abnormal voltage drops and wave-form distortion ultimately attributed to generator's inability to react to system variables. Investigation revealed that generator's transient reactance was abnormally high and the regulator was beyond its field-current range. During the transient period, generator and exciter were, in effect, unregulated and unbalanced resulting in abnormal voltage and third-harmonic effects. Substitution of a generator designed with low transient reactance was the major step toward solving the problem of stable output.

Present trend for computers and electronic systems runs to extremely well-regulated well-balanced and low-harmonic 400-cycle service. A generator must be specified and designed for 400-cycle voltage transients, voltage response, voltage regulation, voltage modulation, voltage balance, wave form and frequency transients, if it is to give satisfactory service on inductive or pulsing loads.

**Adequate generator specs** are required for a successful system design and operation and should be developed with due consideration given to overall system variables. Because of the great number of variables a generalized specification could be misleading. Plant engineers experienced in this field should develop specifications according to their particular system requirements, while those who are not experienced should take advantage of engineering services offered by apparatus manufacturers.

**Overall design** of an adequate 400-cycle system will vary according to load distribution, type of load, usage factor, 60-cycle capacity for larger motor operation, allowable wave-form distortion, etc. It is difficult to establish general ground rules valid for all plants, but we feel that these recommendations will assist in establishing basis for a good system:

1. A good set of motor-generator specs should be developed so that minimum mechanical, electrical and control standards are firmly established. Any applicable NEMA standards should be incorporated for mechanical reliability, standardization of apparatus and limitation of 60-cycle starting demand
2. 400-cycle plug-in bus systems are adequate for low-voltage distributed loads. But they must be correctly rated for load inductive and transient conditions
3. Cable installations are more adaptable to high-voltage distribution. Cables must be multiconductor, designed for 400-cycle application, and line impedances can be varied according to number of parallel conductors per phase. Distribution of medium-voltage (over 601-v) power is definitely a cable application and at present rate of increased applications of this power, higher-voltage distribution from central units will be common
4. On some systems where extreme voltage or distortion control is necessary, 400-cycle condensers will be required. These applications should be carefully checked to avoid voltage rise at low load. Sometimes it is necessary to use a resistive dummy load for line stabilization at lower loads
5. Remote sensing from the load area is helpful in minimizing the effects of line drop but is limited to concentrated loads. Sensing line should also be 3-phase multiconductor cable to avoid voltage unbalances in the sensing circuit
6. Magnetic-amplifier voltage regulators are very accurate in controlling generator output voltage and are recommended, but amount of wave-form distortion must be firmly established. A poorly designed regulator can create objectionable distortions in the fundamental wave which are not easily removed from the output
7. 400-cycle m-g sets generally have a noise characteristic objectionable to plant personnel. Noise suppressors, remote locations or enclosures should be considered in developing overall system design

All 400-cycle systems must be installed *precisely* to the engineer's design. Contractors in general are not familiar with higher-frequency installations. Be positive they adhere strictly to installation blueprints and specifications for particular system.

**AIEE Switchgear Committee is pushing for revision of ASA Standards covering ac power circuit breakers. Proposal will affect rating, testing, application. Big question is . . .**

# How will change in circuit-breaker standards affect you?

Improved standards for ac power circuit breakers have been the object of studies conducted for a number of years by working groups of the Subcommittee on Power Circuit Breakers of the American Institute of Electrical Engineers. Subcommittee proposes revision of several ASA standards; revisions were presented in three papers at the Winter General Meeting. There was a discussion of the proposals by General Electric's L G Levoy who contended that some of the new standards would cause difficulties in selection of circuit breakers for many industrial-distribution systems. In conversations with POWER editors some leading industrial electrical engineers have expressed concern about effect of new standards. They recommend careful study of proposals before adoption to insure practicability in industrial systems.

## What standards are involved?

Included in the three papers are new standards for *Alternating-current power circuit breakers:* (1) ASA C37.3, *Definitions pertaining to,* in paper No. 60-151 (2) ASA C37.4, *Rating structure for,* in 60-151 (3) ASA C37.5, *Methods for determining the value of a sinusoidal current wave and a normal frequency recovery voltage,* in 60-152 (4) ASA C37.9, *Test procedure for,* in 60-152 (5) ASA C37.10, *Application guide for,* in 60-153.

## Why the proposed revision?

*Definitions* covers terms used in establishing rating structure, test procedure and application guide (C37.4 through C37.12) applying to indoor and outdoor ac power breakers rated over 1500 volts.

*Rating structure* establishes a basis for rating power circuit breakers according to symmetrical interrupting amperes in order to (1) simplify application where high-speed relaying and fast-clearing circuit breakers are used (2) bring ASA standards into closer agreement with international standards and avoid confusion on rating differences (3) require that breakers be proved to demonstrate a definite relationship between asymmetrical capability and symmetrical short-circuit-current rating.

*Methods for sinusoidal current wave and recovery voltage* explains how to use oscillograms to determine values of short-circuit currents and transient normal-frequency voltages used in describing circuit-breaker ratings.

*Test procedure* describes design, production, after-delivery, field and acceptance tests required to demonstrate ratings under ASA standards.

*Application guide* is intended for general use and much of the information included has not appeared before in ASA standards. Proposed methods of short-circuit-current calculation are intended to demonstrate and clarify symmetrical as well as asymmetrical requirements. Procedure provides a choice of three methods varying in complexity and rigor. Intermediate method, which is favored, involves resistance and reactance calculations to provide a greater accuracy than that given by the simplified method of ASA C37.5—1953. Greater accuracy than simplest method gives is sometimes needed, particularly in the utility power industry, because of larger generators and transformers, higher voltages, faster circuit breakers.

## Where standards meet opposition

Criticism by L G Levoy, who is Manager, Industrial Power Systems Engineering, Industrial Engineering Section of the General Electric Company, was concerned with the *Application guide* as it applied to industrial systems. In his opinion, the use of proposed method (2) in a typical industrial-distribution system will impose problems which may discourage sound engineering in circuit-breaker application. This method, in many cases, would require solution of the resistance network formed by the system as well as reactance calculations. Obtaining significant resistance data on all the components of an industrial system would usually be a formidable task.

Present methods have been generally adequate in practice, and are realistic in regard to work required. Refinements which are not necessary to assure proper selection should be avoided.

**CENTRAL CONTROL ROOM** for large water-distributing system includes supervisory network and control stations to permit lone operator to monitor unattended wells, pumping stations and water tanks. Recorders operate from transmitted timed-duration signals

# Why frequency coding for supervisory

PART 2

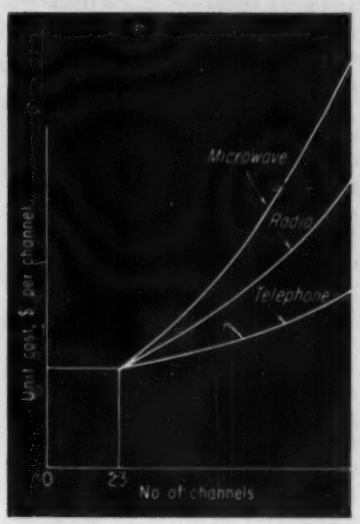
**One reason: be able to send many distinct signals simultaneously over the same wires. Coming: Part 3, with tips on specifying entire systems**

Supervisory systems now comprise a considerable portion of expanding industrial and utility control networks. To keep you up to date on all types of control and monitoring systems you may be called on to apply, we continue with Part 2 of POWER's series on supervisory systems. Part 1 of this series (POWER, August 1959, pp 68-70) described the increasing use of remote control for supervision of power-company, pipeline and water-company substations and many more widely dispersed industries. Some communications links between the several plants of any one of these industries are the telephone line, microwave link, power-line carrier or radiotelephone. Common denominator for these links is the audio frequency, so using coded audio frequencies for remote supervision and control is a logical application of this usually ready-made network joining company's plants.

**Building a system** for remote control and supervision entails selection of communication link and type of coding. Methods of coding are selected for maximum control flexibility and speed of supervisory report-back at minimum cost. Where an audio link exists, it should be checked for suitability. If system requirements exceed capabilities of the existing link, selection of an additional link is based on design factors of distances between stations, physical barriers, number of stations, etc (Part 1 gave additional info on link selection).

**Most common medium** in use is the leased telephone line. Usable frequency spectrum for most telephone lines, without excessive distortion or line loss, is in the range of 400 to 2500 cps. Audio-tone transmitters can yield up to 23 separate tones over this band width which can be simultaneously transmitted on a single telephone pair. Low-loss lines for special purposes and radio links can, of course, utilize a much larger number of audio frequencies, but at a higher lease rate or higher initial cost.

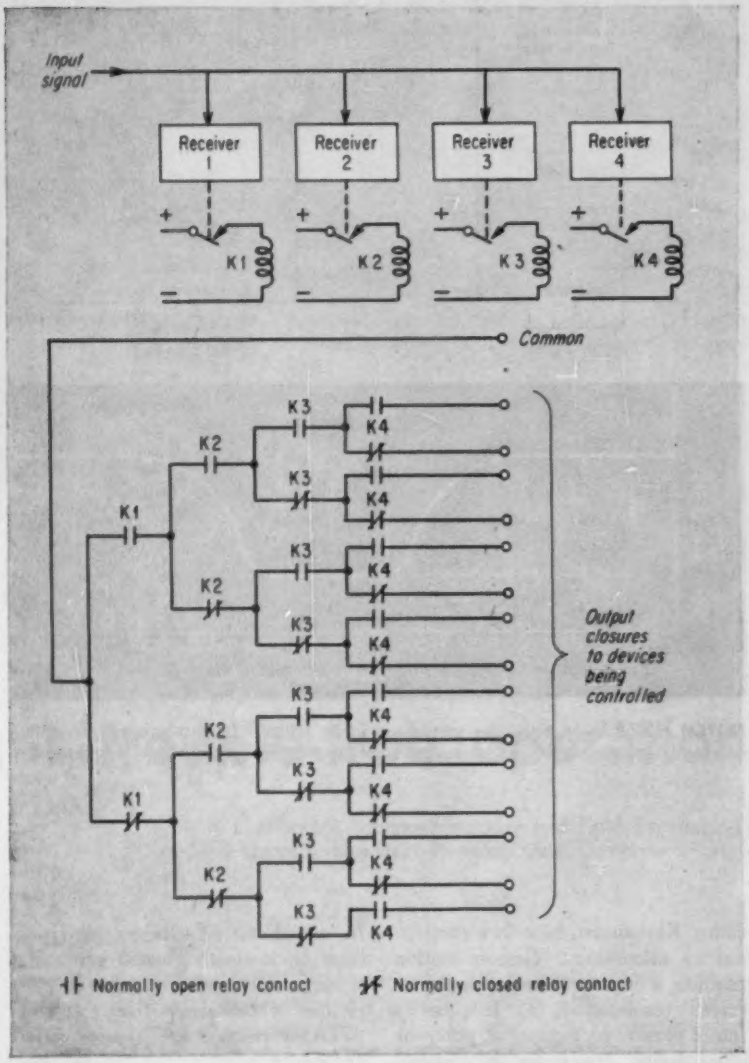
Approximate tone rates are plotted above. Unit cost per tone remains constant up to approximately 23 tones. For each additional tone beyond 23, unit cost rises varying amounts for the different types of channels. When selecting data points or control points keep these unit costs in mind, for one additional point




**UNIT COST** for each tone above 23 goes up rapidly due to added system complexity

# systems?

By H BERNSTEIN, Project Engineer
Centralized Operations Control Group, The Hammarlund Manufacturing Co, Inc




**"TREE" CODING NETWORK** affords maximum number of usable codes from given tone channels. Remote station requires decoder to translate string of tones into final signal

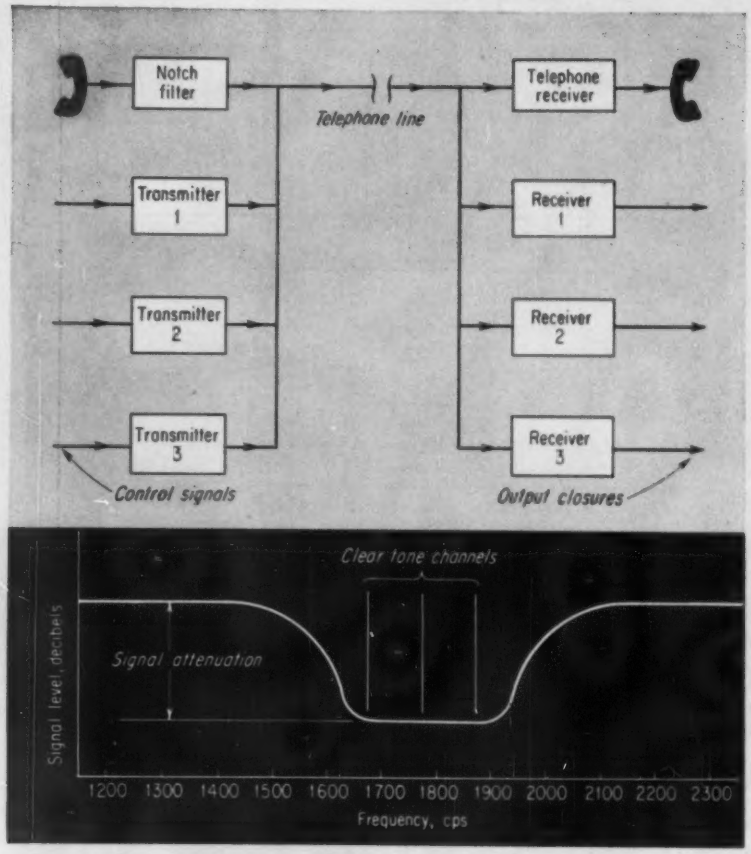
may represent an increase in system cost which can't be justified by value of the data collected or control function permitted.

**Coding method** for any one installation is determined by the requirements for that installation. Typical considerations are degree of security required, quantity of points to be controlled or supervised, permissible time of response to a control signal and need for simultaneous voice communication on same line.

Simplest code assigns a continuous frequency "on" tone to device to be held on. For example, if operator at a master station wishes to turn on a motor at a distant substation he throws a switch to "on". This places an audio tone on the line. Receiver at the substation maintains a steady contact closure which starts the motor. Turning the master-station switch to "off" removes signal, stops motor.

Selection and command coding for control is one of the more common methods. In this coding a tone is assigned to each point to be selected, and a common tone to each command (ie, frequency *A* for "open", frequency *B* for "close"). Any one signal will therefore transmit two frequencies, and will have to be momentary because the common command tones are shared by many points. For this type of code, latching-memory relays are required for each point at the receiving station to "remember" and maintain closures to the equipment.

**"Tree" codes** utilize a group of frequencies, five for example, which, keyed from a master station in all combinations, will yield 31 usable




**NOTCH FILTER** stops voice-tone transmission over selected frequency bands to permit uninterrupted tone signaling. Attenuated voice frequencies do not affect comprehension

codes. Keying can be either continuous or momentary. Remote station requires a decoder to translate the received combination of frequencies into a closure to the motor, pump or other device. Tree codes are economical of available frequency spectrum and should be used: (1) when limited number of frequencies are available for control (2) when frequency spectrum also has other uses (3) when many individual frequencies are used on same telephone line for supervision of on-off devices (4) for telemetering of pressure or voltage, or other continuously varying and continuously monitored quantities (5) to save a portion of the spectrum for voice communication. In case (5), filters prevent voice frequencies from operating control circuits or affecting supervisory display circuits. A typical decoder tree circuit is shown on p 103.

In actual circuit design, provision must be made to prevent erroneous closures due to discrepancies in pull-in time of the various relays.

Tree codes for use in supervision are similar to those for control, with the additional factor that under supervision there is no human operator present to select individual supervisory codes in sequence, each utilizing a separate combination of coded tones. Automatic programing devices at the distant stations must interpose between contacts of the device being supervised and tone transmitters, so changes in state are recognized, stored and sequentially keyed onto the transmitter. Programers also are needed so that when simultaneous change occurs two or more codes are not keyed onto the line together, resulting in transmission of a spurious code to the master station.

**Address codes** represent a further step. Multiplication of capacity can be accomplished by assigning a number of single tones as general addresses for each of several stations, and using remainder of the frequency spectrum in combination with these tones for controlling or supervising a larger number of points.

**Keying operations** can be simple on-off or frequency-shift signals. Frequency-shift keying is performed by shifting above or below center frequency. For extra use of available frequency spectrum, center frequency can be interrupted for coding.

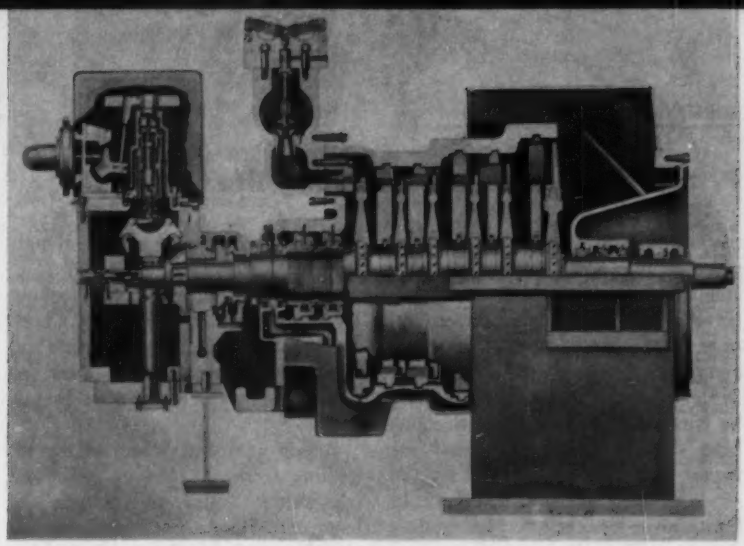
**Pulse systems,** either pulse count, pulse spacing or pulse width, are often used in combination with audio tones to give an integrated supervisory-control system. Same pulse-width code carried on two different frequencies can be used on the same line simultaneously for control and supervision. Pulse-duration telemetering of 15 to 20 quantities, each on a different frequency, can be simultaneously carried on the same line. Usual telemetering of variables makes use of pulse-duration signals since direct transmission of analog quantities is expensive and difficult. Line losses and distortion cut analog accuracy on long-distance transmission usually found in supervisory systems. Digital telemetering may appear in future systems.

**Voice-shared systems** require that voice be carried on the communication medium at the same time as coded frequencies. Initial consideration is degree of fidelity required for voice.

When a limited number of tone channels are required, notch filters, shown above, can be used. Each will cut, for example, three frequencies out of all voice communications so that these can be used for supervisory control. Notch filter allows most of the voice frequencies to pass and usually is not noticeable in ordinary conversation. Where only requirement is that conversations be understood, low-pass filters are used.

**Combining techniques** we have listed builds up a complete supervisory system to handle operations as complex as remote control of all equipment in a large group of unattended pumping or transfer stations. Part 3 of this series will describe application of frequency coding to several complete supervisory systems.

Mechanical-drive turbines—14



**TYPICAL MECHANICAL-DRIVE TURBINE** designed for throttle pressures of 150 to 850 psig and temperatures to 825 F. Condensing unit runs at 6500- to 10,000-rpm speed

**Designers strive to make their machines work with maximum reliability. But reaching this goal depends on installing the unit properly and knowing . . .**

# How to get trouble-free operation

By R A BRIDGMAN, Manager, Factory and Field Engineering
Small Steam Turbine Dept, General Electric Company

Trouble-free operation of m-d turbines depends on: (1) correct installation (2) proper operation and (3) effective maintenance. In this article we'll concentrate on the first two factors; later we'll cover maintenance procedures.

**Installation.** Main factor fixing the location of a mechanical-drive turbine is site of the machine to be driven. Plans should provide, if at all possible, adequate space around the turbine and its accessories for inspection, efficient and safe operation and paintaking maintenance procedures. Preferably the turbine equipment should be protected from excessive dust, moisture, drips and undesirable environment, if feasible.

Unit should be set on an adequate and substantial foundation of enough mass and strength to support turbine, gear and base without excessive deflection. Concrete of the proper consistency fulfills these needs.

Turbine, gear and line shaft should be adjusted so that flexible couplings will align properly at running temperature. When aligning everything at room temperature an estimated allowance for vertical shaft rise because of temperature changes in the supports should be made.

Most instruction books give estimated amounts of shaft rise as a function of exhaust or inlet temperatures. This data being approximate, the only satisfactory method of assuring good alignment at operating temperature depends on running the units until they reach this temperature, then shutting down quickly to make an accurate check between coupling halves with dial indicators. Usually one more correction will bring coupling halves into satisfactory alignment.

A relief valve capable of passing maximum nozzle flow at the maximum allowable exhaust pressure should always be installed between turbine exhaust and the first shutoff valve in the exhaust line. This is the safest way of preventing accidental overpressuring of the turbine exhaust casing.

When the couplings have been aligned and the turbine and gear mounting feet securely bolted and doweled to the base, turbine is ready for connecting steam piping. First, new piping should be thoroughly blown down to clear out all foreign

## Proper operation assures long life

material. When this is impractical, place a fine mesh screen over the standard strainer in the turbine-trip throttle valve. Leave the screen on only for the first few days of initial running.

Steam and exhaust pipes should be connected to their respective turbine flanges, taking care that the forces and moments exerted by the pipes on the turbine are well within limits given on each turbine outline drawing. These limits on forces and moments are derived from the latest NEMA Standards (see *How to connect piping to steam turbines*, POWER, July 1957, pp 92-95).

A certain amount of flexibility *must* be designed into modern turbine supports, particularly the larger ones, to allow for expansion of the metal while heating. This flexibility limits the forces and moments that can be imposed on the turbine without causing excessive misalignment of the turbine shaft with respect to the driven shaft.

Shaft-packing-box drains and turbine-casing drains should be properly connected to headers of proper size and working pressure as specified in the turbine outline drawing. Same care should be used with other connections such as speed-changing-motor ties and oil-cooler water lines.

When any oil piping for the turbine unit is shipped loose and installed at the site, turbine oil system should be flushed by filling the reservoir with flushing oil. This oil should be circulated through the unit with the auxiliary oil pump. Temporary strainers should be installed ahead of bearing and governing systems if available; if not, oil lines should be blanked off just ahead of the bearings and the hydraulic governing system.

After flushing for two to three hours, shut down the oil pump and remove the flushing oil, remove temporary strainers or blanks and wipe down the oil reservoir. Then refill the reservoir with proper grade of turbine oil to proper level.

**Initial operation.** When making initial startup of the unit, first establish oil pressure with the auxiliary oil pump, and check for oil leaks throughout the piping system. Repair them immediately.

Adjust oil pressure to working level by setting the relief valve. Check action of low-oil-pressure trips and remote solenoid trips. Roll turbine rotor by hand to make sure that it is free.

Before admitting steam to the inlet line from the header, open the trip throttle valve and actuate the hand trip. Reset throttle valve to the closed position. Open all turbine drains and above-seat throttle-valve drains in the steam inlet line. Open the exhaust valve slowly; wait until pressure builds up in exhaust casing to rated value before opening this valve wide. Admit steam to the inlet pipe up to the throttle valve slowly. Make sure all water is drained out ahead of the throttle valve.

Start unit rolling. When throttle valve is open part way, check manual trip action again. Reset trip throttle valve.

Bring the unit up to rated speed very gradually, checking carefully for rubs and excessive vibrations. *At no time* should vibrations be allowed to exceed 0.003 in. on the turbine shaft. To repeat, be very careful and take plenty of time to bring the unit up to rated speed.

Check governing action throughout the governing range. Check the emergency governor trip setting by bringing speed up to the specified trip speed. Emergency governor and throttle valve should trip within ± 2% of the specified trip speed. If trip does not actuate within this range, emergency governor should be readjusted under the supervision of a qualified manufacturer's representative.

If all initial checks work out satisfactorily, the unit may be secured and coupled up to the load.

**Routine starting.** Prior to every startup, all safety devices should be checked for proper operation. Starting procedure parallels that for initial starting, except that operation at low speeds is necessary only until it can be ascertained that the turbine rotor has heated evenly. When we know the rotor does not have a heat bow, the unit can be brought up to speed more rapidly than on initial startup. Particular care should be taken with turbine restarting when unit has cooled only part way to room temperature.

Usual recommendations in instruction books on accelerating time during starting are conservative, being on the order of 30 min or so to reach full speed. Actually, speed could be brought up faster as long as there is no water in the steam lines and the shaft has no bow from uneven heating. This last item is critical—the longer the rotor stands in steam without turning, the greater the chances of a heat bow, and the longer the rotor needs turning at low speeds to equalize heat in the rotor.

When starting a turbine needing gland-sealing steam, turn over rotor immediately after admitting steam to packing glands. Best advice we can give is to take the time recommended in the instruction book.

**Checks and tests.** While the turbine runs, performance measurements should be taken at regular intervals and recorded. We recommend hourly checks of oil temperatures and pressures, and weekly checks of vibrations. Maximum permissible temperature rise in oil from the inlet to outlet of a bearing housing should be considered as 50 F. Maximum temperature of oil out of a bearing housing should be about 170 F.

One of the most important things to notice is any sudden change in bearing temperature. Investigate to find the cause immediately, even if it means shutting down the unit. Any marked changes in general sound level or frequency should be noted and the cause determined.

Once a shift, or once a day, the trip throttle valve should be closed a number of turns so that the valve stem can be seen to move slightly. Then open the throttle back up. This operation assures that valve stem is perfectly free in its bushings.

Operating oil level in the reservoir should be checked periodically. Oil tank should be kept at as high a temperature as possible. Cooling lube oil excessively should be avoided; it usually leads to condensation and

rusting inside the turbine oil tank.

Many mechanical-drive turbines have an electrically driven main oil pump and similar auxiliary oil pump driven by a steam turbine under the control of a pressure regulator. Starting action of the turbine-driven oil pump should be tested periodically by securing the switch to the motor-operated oil pump. This had best be done when turbine is down for a short time so that if slight governing disturbances result from the testing, production will not be affected.

Watch the governing system frequently to check its holding speed within required limits.

**Securing the unit.** Always stop the turbine by actuating the manual-trip device. This will allow the throttle to close under spring pressure only. If throttle is closed by the hand wheel while hot, later contraction of the metal parts while cooling may possibly cause jamming.

Shut off gland steam, if provided, as soon as rotor stops turning.

Close the exhaust valve. Open all turbine-casing drains wide. Run the auxiliary oil pump for a few minutes after the unit comes to rest.

Emergency overspeed and trip throttle valves should be tested at least once a month if practical—never less than every six months. If the driven equipment can stand the overspeed these tests can be made easily. If not, driven equipment must first be disconnected.

**Lubricating oil.** Turbine instruction book specifies the lubricating oil that should be used in the unit. These specs should be followed scrupulously for best performance.

Recommended oil level in the reservoir should be held at all times. Too high an oil level may bring the oil in contact with the reduction-gear teeth and cause severe foaming, or it may block certain oil-return lines coming into the tank. Too low an oil level raises the danger of sucking air into the oil-pump suction pipe, contributing to oil foaming at the bearings and to governing disturbances from entrained air in the m-d turbine governor's oil system.

Leaving cooling-water-control valves wide open on oil coolers regardless of the temperature of the inlet water is a frequent cause of low oil-tank temperature. If this water is unusually cold, temperature of oil passing through the cooler will be lowered excessively, leading to low tank temperatures and condensation of moisture. To handle low inlet-water temperature situations, install a small control valve in parallel with the large main valve. This will allow throttling the water flow without danger of clogging the main valve. Cooling-water throttling valves should be installed in the outlet pipe from the cooler to avoid tube erosion from excessive water velocity.

At about yearly intervals, an analysis of oil from the oil reservoir should be made to determine deterioration in respect to antioxidizing additives, acid content, antifoaming and antisludging additives. Turbine instruction books give limiting values for these factors.

# Coal-burning gas turbine teams up with steam plant

American Electric Power Co will add a General Electric Company coal-burning gas turbine to its Muskingum River Plant of the Ohio Power Co at Beverly, Ohio. The 5-mw prototype turbine, burning coal gas, will run in a combined cycle with one of plant's existing 215-mw steam-turbine units. Placed in an extension of the present building, unit will be running by spring of 1961.

**Combined cycle** aims to raise overall plant thermal efficiency. Predicted full-scale application, in the future, of this cycle promises an increase of 4% in efficiency. Because of the experimental aspects, only a part of potential gas-turbine capacity is being used in conjunction with the 215-mw steam unit. Successful operation of this installation is expected to lead to combinations that will need much larger gas turbines than are available to date.

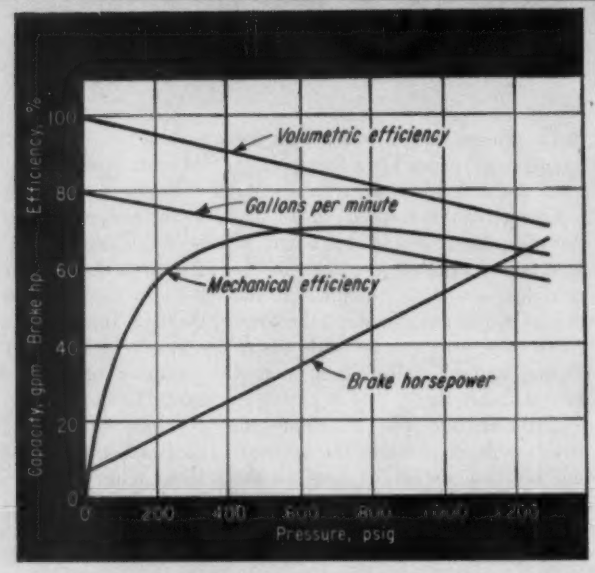
**Operating cycle.** Coal for the 5-mw turbine will be broken down in a carbonizer at high temperature to produce both coal gas and char. The coal gas will burn in the gas-turbine combustor, producing a clean hot gas. Char goes to an existing cyclone burner on the steam generator supplying the steam turbine.

A separator between carbonizer and gas-turbine combustor takes out all solid particles and sends them with the char to the cyclone burner. A booster compressor on the gas-turbine-unit shaft raises coal-gas pressure for injection into the gas turbine's combustor.

Hot gas-turbine exhaust goes to the cyclone burner to join preheated air supplied for burning pulverized coal and char. This complete integration of the two types of unit may prove the answer to economical coal burning for stationary gas turbines. This will be first unit to burn coal for commercial electric energy.

**Cyclone-fired** furnaces work with h-p f-d fans and usually eliminate the i-d fans. Full-scale application of gas turbines to supply all air for the steam-generator furnace could eliminate need for f-d fans. Gas-turbine backpressure could be raised enough to push combustion gas through the entire steam-generator furnace to the stack.

General Electric Company will supply the gas turbine and its controls, the carbonizer and the related coal- and char-feeding devices. American Electric Power Service Corporation will design and build the new coal-burning installation. New unit will be coupled to Unit 1 at Muskingum River, which started operating in 1953. Three similar units give the plant a total generating capacity of 880 mw, making it the largest power station on the 7-state American Electric Power System.




**ROTARY-PUMP PERFORMANCE** curve showing mechanical and volumetric efficiencies. Note peak mechanical efficiency at 700 psi

# Here's how to figure rotary-pump efficiency and hp

## Volumetric and mechanical efficiencies are both important. In applying pumps, know how to use them

By A A ZALIS, Chief Engineer, Rotary Pump Div, Warren Pumps, Inc

*In February* POWER, *A A Zalis discussed some rotary-pump types and their areas of application. Here, he takes up hydraulic performance as it affects driver selection.*

**Volumetric efficiency** in a rotary pump is the ratio of delivered capacity at rated pressure to capacity at zero pressure, assuming no inlet losses:

$$E_v = \frac{gpm \text{ (at rated } psig)}{gpm \text{ (at zero } psig)}$$

At zero-psig pressure, of course, a rotary pump has a volumetric efficiency of 100%. Since capacity-vs-pressure curve is a straight line, volumetric-efficiency curve is also a straight line. Volumetric efficiency is a measure of internal pump slippage. In most general-purpose applications it doesn't matter much, but on chemical service where pump may be used for metering, volumetric efficiency can be very important.

Viscosity changes in the liquid pumped affect internal slippage, and therefore volumetric efficiency. Slope of the capacity-vs-pressure curve is a function of internal slip at various pressures. This slope is dependent on operating clearances, viscosity and pressure. A decrease in viscosity increases the slope of the capacity-vs-pressure curve and decreases the volumetric efficiency.

**Mechanical efficiency** is a basis for evaluation and a means of checking pump condition:

$$E_m = \frac{gpm \text{ (at rated } psig) \times psig}{1714 \times bhp}$$

It is the ratio of hp input to hp output. Curve of mechanical efficiency vs pressure starts at zero efficiency, zero pressure and goes to a maximum value at a certain design pressure. At greater pressures it again falls off.

**Brake horsepower** of a rotary pump is the sum of hydraulic hp at the operating point and frictional hp:

$$hp = hp_{hyd} + hp_{frtn}$$

Hydraulic hp is a function of capacity and pressure, but is not related to viscosity:

$$hp_{hyd} = \frac{gpm \text{ (at zero } psig) \times psig}{1714}$$

In calculating hydraulic hp, it is important to use capacity at zero psig to account for all energy expended. Otherwise capacity due to slippage losses will be omitted and you won't get a true hp for the pump.

Friction hp includes all internal pump losses such as stuffing-box friction (or mechanical-seal losses where seals are used), bearing losses, gear losses and losses due to fluid friction. Fluid-friction losses are the largest single component of friction hp. When pumpage is a constant-viscosity liquid, friction hp is constant regardless of capacity or pressure. For a particular pump, friction hp is equal to total hp at zero psi.

**Speed change** affects efficiency and brake hp. Friction hp varies as the square of speed change while hydraulic hp is a linear function:

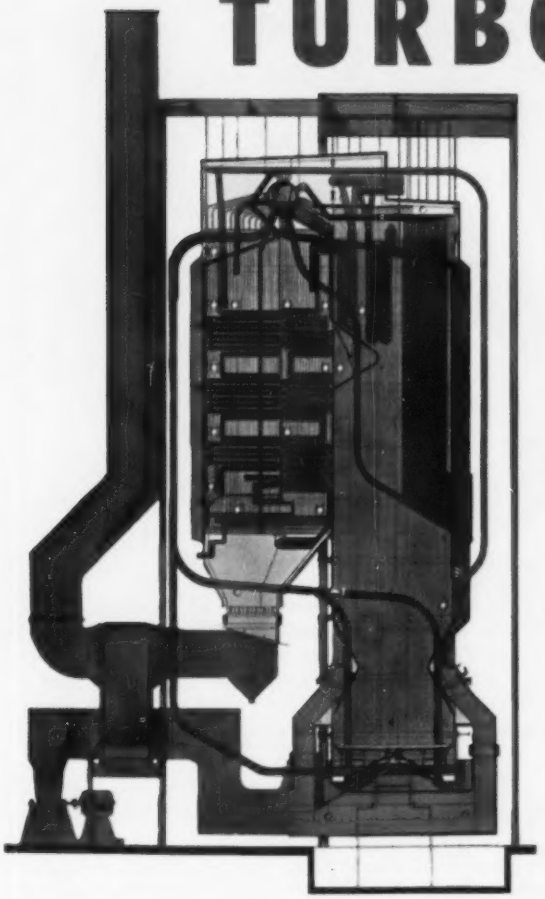
$$hp = hp_{hyd}\left(\frac{N_1}{N_2}\right) + hp_{frtn}\left(\frac{N_1}{N_2}\right)^2$$

Since friction hp varies as the square of the speed change, its effect on mechanical efficiency is great. As speed reduces, mechanical efficiency increases.

Speed changes also affect volumetric efficiency. Capacity at zero psig increases directly with speed, but slip is constant through any speed change. Therefore, capacity at rated pressure increases slightly more than a true linear function of the speed change, and volumetric efficiency increases slightly with increased speed.

*Your Answer to Full Fuel Utilization in the '60's...*

# ...RILEY Boilers With The TURBO FURNACE



Any fossil fuel can be fired in a Turbo Furnace singly and in any combination. Advanced operating and performance characteristics represent important strides in the art of fuel burning and steam generation. In recent years the Riley Turbo Furnace Boiler, a relatively new concept of boiler-furnace design, has been widely accepted by public utilities, manufacturing industries and their consulting engineers.

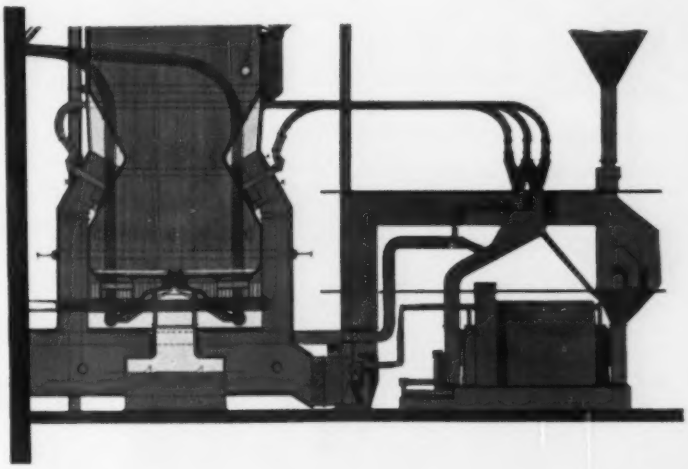
Turbo Furnace Boilers now in operation and under construction range in size from industrial type installations to high capacity central station units. Many Turbo Furnace Boilers are pressurized. Some are designed to fire coal, oil and gas separately or in any combination depending on B.T.U. cost of fuel.

Coal fired Turbo Furnace Boilers have these advantages: the elimination of the problem and cost of flyash disposal, the elimination of slag blowers, the ability to tap slag through a wide load range. Four Turbo Furnace Boilers are successfully firing fluid coke, which is handled as a pulverized fuel.

Many boilers of this design were purchased in anticipation of a changing fuel market because the design offers a simple low cost means of transition from one fuel to another.

The 1,650,000 lb/hr Turbo Furnace reheat boiler design for Louisiana Power and Light Company's new Little Gypsy Steam Electric Station . . . pioneer in complete automatic operation. Boiler operation at 2350 psig, 1005 F. superheat, reheat; pressurized.

*Because the basic design of the Riley Turbo Furnace Boiler is suited to firing a wide variety of fuels, a boiler initially installed to burn oil and gas requires little alteration to equip it to burn pulverized coal. The design at right is a boiler originally installed for oil and gas. Many of the provisions for pulverized coal firing are accomplished externally while the boiler is kept in service on oil or gas.*



*A careful survey of your plant by a qualified consulting engineer could show ways of making substantial savings in power costs.*

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT

## *Here Are Some Desirable Characteristics You'll Find In A Riley Turbo Furnace Boiler*

### *Simplified Steam Temperature Control*

Performance varies little with type and grade of fuel being burned. Furnace exit temperature is lower than for horizontally fired boilers of equal heat release rates because heat absorbing surfaces are used more effectively. This simplifies steam temperature control.

### *Reduces Flyash Problems*

Reinjection of flyash and continuous molten ash discharge eliminate costly flyash collection and disposal problems. Flyash combustible losses are eliminated. Some installations receive flyash from adjacent dry bottom units for disposal in the Turbo Furnace.

### *Reduction of Air Pollution*

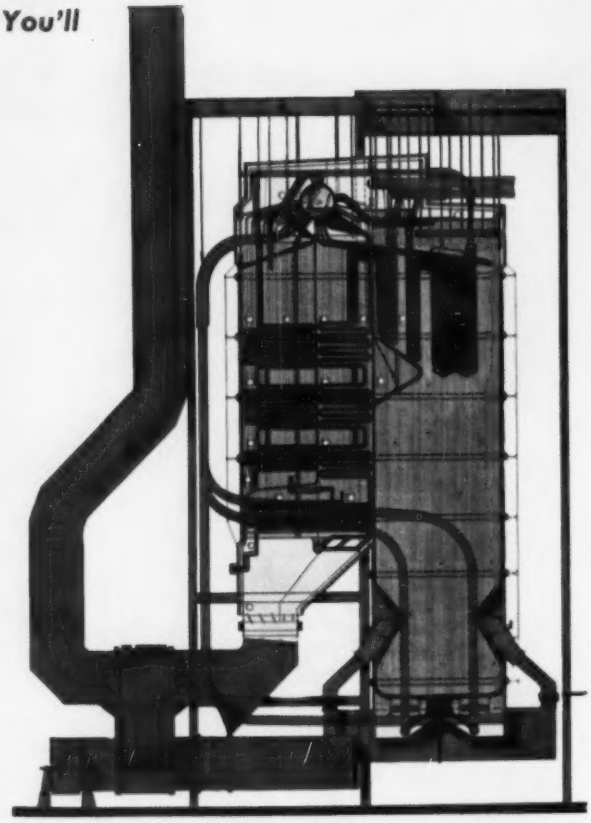
Because of the burning method, flue gases contain lower quantities of objectionable oxides of nitrogen.

### *Continuous Slag Tapping At Low Loads*

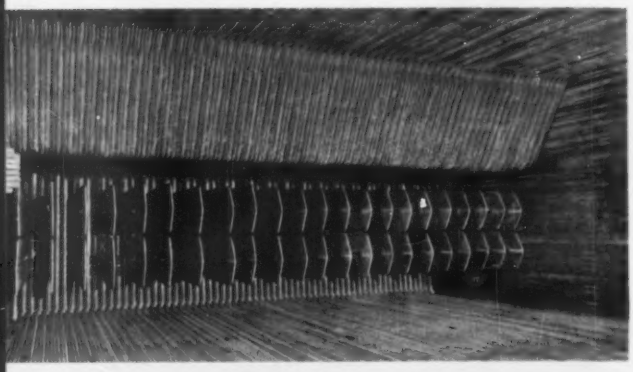
Burners are directed downward and fire on the floor around the tap hole assuring tapping at low load operation and making possible the use of higher fusion coals. Continuous flow of slag has been obtained at 25% of maximum continuous rating.

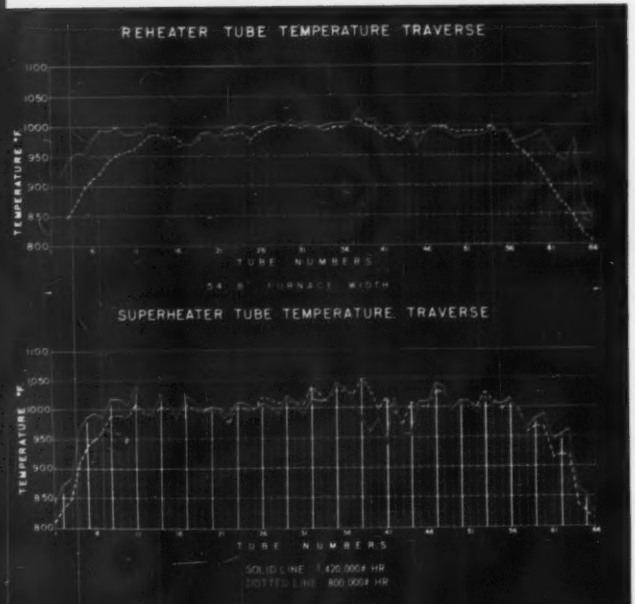
### *No Furnace Wall Deslaggers are Normally Required*

Because of high ash retention in the bottom and the uniform vertical gas flow pattern furnace wall slagging is substantially eliminated.



The 1,550,000 lb/hr Turbo Furnace Boiler at Louisiana Power & Light Company's Sterlington (La.) Steam Electric Station, 2125 psig, 1005/1005 F pressurized. At left—View across 55 foot wide furnace at superheater elevation.






### *Higher Heat Releases Permitted*

The fuel is burned within the Turbo Furnace bottom, just above the Turbo Furnace floor . . . the entire furnace wall area is available for heat recovery. The nominal heat release may thus be higher than for horizontally fired boilers.

### *Lower External Structure Cost*

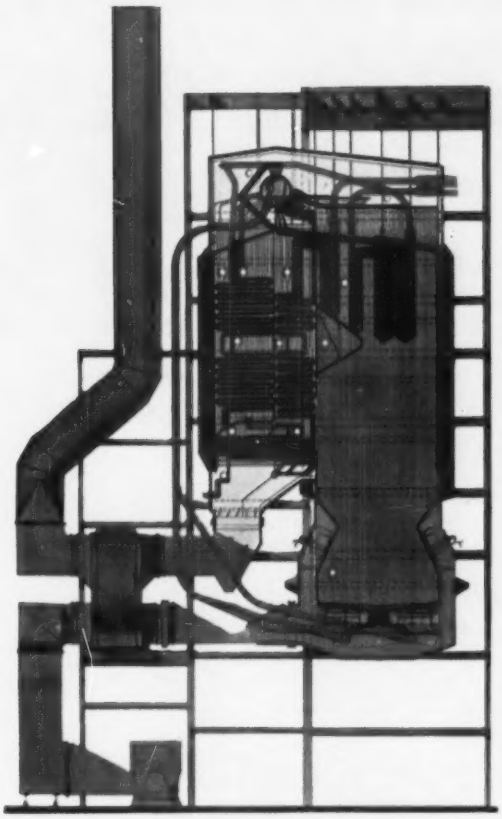
With lower furnace heat releases permitted the Riley Turbo Furnace boiler occupies less cubical space. One burner level eliminates platform and ladder construction costs.

### *Wider Single Furnace Boiler Units Permitted*

Furnace design, combined with the opposed method of firing, controls gas flow pattern to remove limitations on furnace widths inherent with other methods of firing. Gas temperature traverses at the furnace exit are extremely uniform.

### *Minimum Metal Temperature Variations Due To Uniform Gas Flow*

The view at left and chart are of the 55 foot wide single furnace of the 1,550,000 lb/hr unit above. Furnace has no division walls or platens. The chart shows the uniform metal temperature gradient of superheater and reheater tubes spaced across the width of the furnace. The maximum variation above the normal 1005 F is well within safe limits assuring long metal life. The chart also shows the same uniform pattern for lower loads.

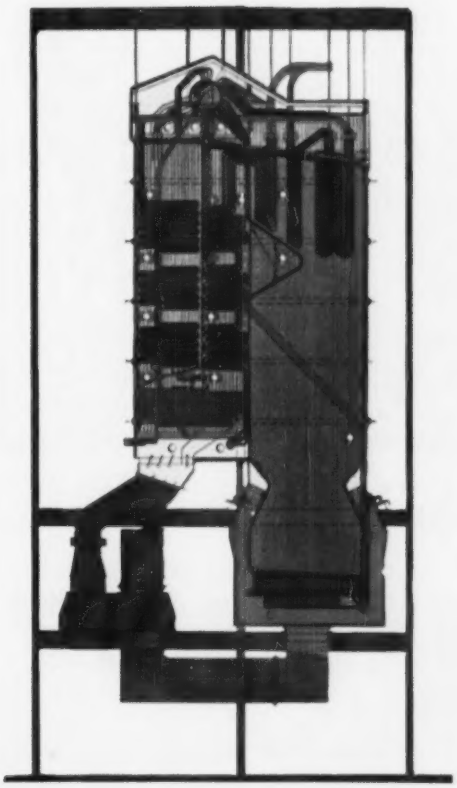


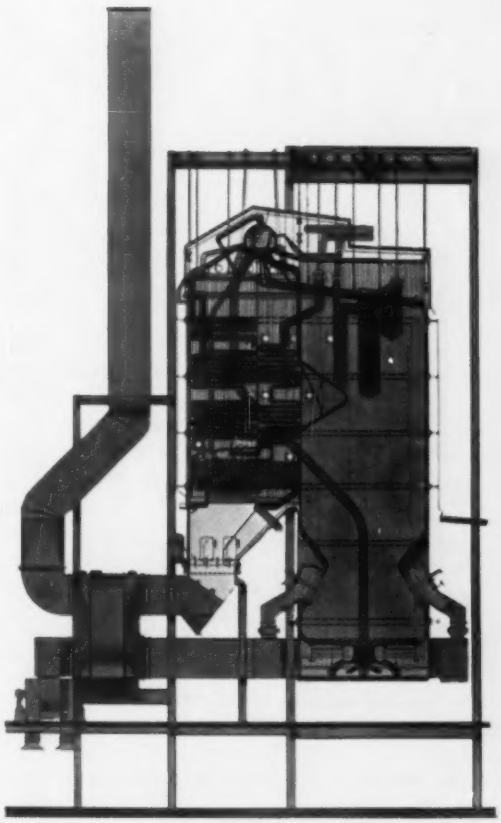
# TYPICAL RILEY TURBO FURNACE BOILER INSTALLATIONS

*At left* — North Lake Steam Electric Station, Dallas Power & Light Company. 1,200,000 lbs/hr — 2125 psig, 1005/1005 F with pressurized Turbo Furnace. Fired by natural gas and oil.

*Lower left* — Turner Unit No. 4, Florida Power Corporation. 600,000 lbs/hr—1650 psig, 1000/1000 F. Fired by oil and natural gas.

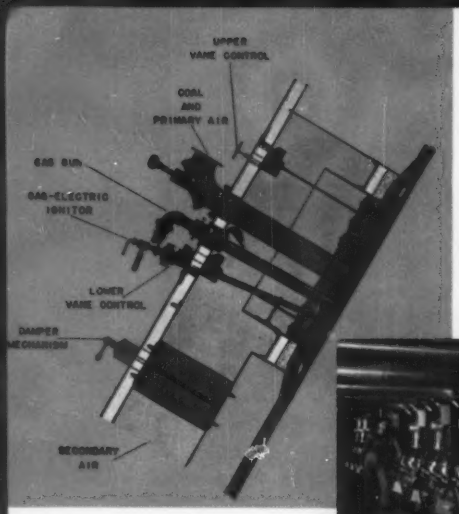
*Below* — Permian Basin Steam Electric Station, Texas Electric Service Company, 825,000 lbs/hr, 1750 psig, 1005/1005 F. pressurized. Fired by natural gas, oil, (Future pulverized coal).

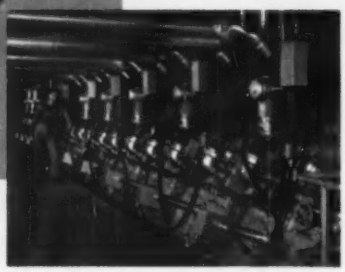




RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT



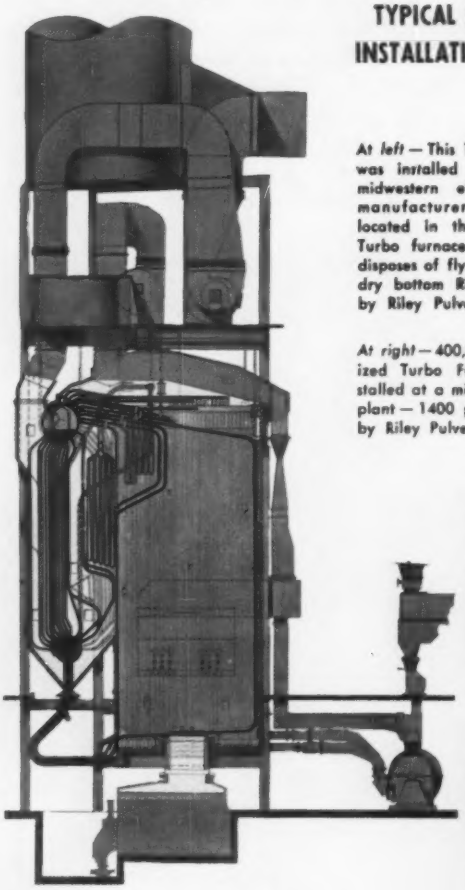
## *Turbo Furnace Burner Maintains Stable Flames Over Wide Load Ranges.*

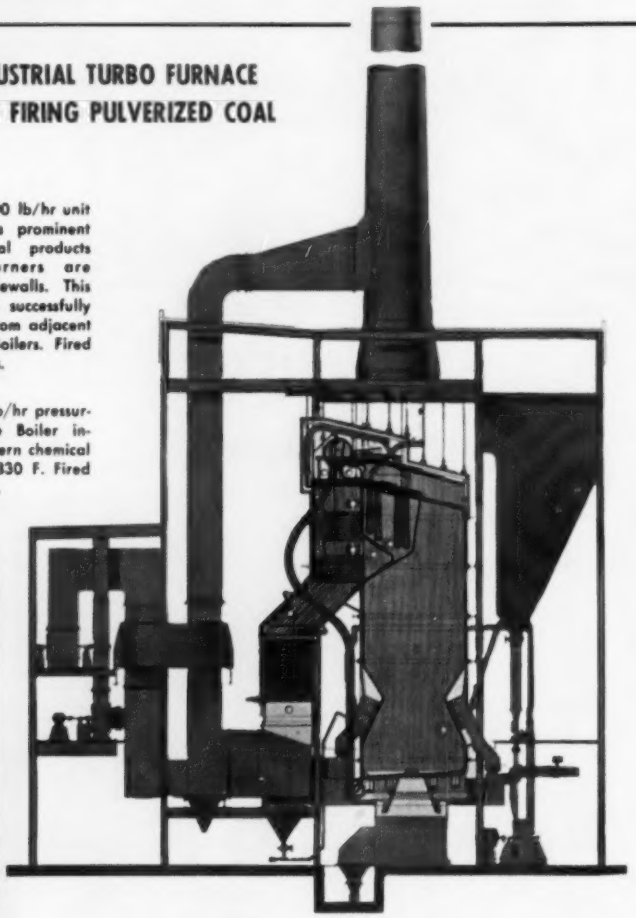
Riley Directional Flame Burners are designed expressly for the Turbo Furnace to burn gas and oil and pulverized fuels that are burned in suspension such as coal, lignite, fluid coke, delayed coke, etc. Burners are arranged for opposed firing on one level. Fuel and combustion air are introduced thru openings between furnace wall tubes. There is no exposed refractory to maintain. Directional vanes control placement of flame. Turn down ratio for gas is limited by gas flow control system; minimum load for oil is limited only by oil atomization (7 to 1 ratios have been attained). Stable flames with coal firing are easily maintained on a 5 to 1 load ratio.

### TYPICAL INDUSTRIAL TURBO FURNACE INSTALLATIONS FIRING PULVERIZED COAL

*At left* — This 150,000 lb/hr unit was installed by a prominent midwestern electrical products manufacturer. Burners are located in the sidewalls. This Turbo furnace Unit successfully disposes of flyash from adjacent dry bottom Riley Boilers. Fired by Riley Pulverizers.

*At right* — 400,000 lb/hr pressurized Turbo Furnace Boiler installed at a midwestern chemical plant — 1400 psig, 830 F. Fired by Riley Pulverizers.





Ask your Riley representative for detailed information about Riley Turbo Furnace Boilers — or write direct to RILEY STOKER CORPORATION, WORCESTER, MASSACHUSETTS.

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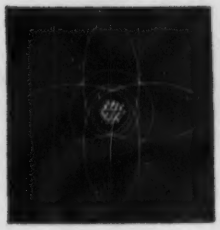


# Nuclear notes

By B G A SKROTZKI, Associate Editor

**Gas-cooled reactor experiment** (GCRE) at the National Reactor Testing Station in Idaho went critical on Feb 23, 1960. The water-moderated and nitrogen-cooled GCRE will generate 2.2 mwt but no electric power. It cost about $4.5 million. Aerojet-General Corporation of Azusa, Calif. designed and built the unit and will run it for the AEC. GCRE is a step in developing a Mobile Low-Power Nuclear Power Plant No. 1 for the Army. This will combine the direct- and closed-cycle gas-cooled reactor system with a gas-turbine-driven power-conversion system to produce about 400 kwe. Plant will run one year without refueling.

**Homogeneous Reactor Experiment No. 2** (HRE2) at Oak Ridge National Laboratory has developed a second ½x1½-in. hole in its zirconium-core tank. This is the same size as the first hole that shut down reactor in April 1958. HRE2 was designed to run with a heavy-water fuel solution of uranyl sulfate circulating in the core region, surrounded by a blanket region of heavy water. Blanket was to reflect neutrons back into the core. Reactor has been run with fuel in both blanket and core. Second hole resulted from experiments run to find out the reason for developing the first hole—holes were believed to have been caused by local hot spots in the core. The holes will be repaired and in about four months the reactor will run again with a different circulation, using the original 2-region design.

**Clarification of AEC policies** on future research and development is urged by the Atomic Industrial Forum. They recommend: (1) better communication of AEC views and plans for future R&D to ease industry's planning (2) better method of presenting industry ideas and proposals to the AEC in field of R&D (3) establishing an Ad Hoc Committee to discuss roles of industry, universities and AEC labs in research and development in the nuclear-power field.

**Zero Gradient Proton Synchrotron** will have the largest power supply of any atom smasher in the U.S. Power-supply unit at Argonne National Laboratory will draw about 200 kwhr from utility mains to drive a 68-ton steel flywheel, 13-ft dia, at 899 rpm. By slowing down to 890 rpm the flywheel gives up about 80% of its kinetic energy to generate a 1-second power pulse of 117 mw for the 4000-ton circular magnet of the 12.5-bev atom smasher. Unit will do this every four seconds. The Synchrotron will be completed in 1962 at a cost of about $29 million.

**Atomic Energy of Canada, Ltd** has awarded a contract to Associated Electric Industries Ltd, of Manchester, England, to supply a 220-mw turbine generator for the Douglas Point Nuclear Power Station. Cost will run about $5.6 million. Turbine will take saturated steam at 565 psig and 430 F. Steam will be reheated to 430 F before entering low-pressure section of turbine.

**Nuclear-plant milestones** include (1) shipment of reactor vessel for Yankee Atomic Electric plant (2) shipment of Elk River reactor pressure vessel (3) breaking ground for the Saxton Nuclear Experimental Corp plant near Saxton, Pa. A specially built flatcar, three times as long as an ordinary freight car, carried the Yankee vessel on the 900-mile trip from B&W's Barberton plant to Rowe, Mass. The pressure vessel for Elk River was built by Pacific Coast Engineering Co in California for Allis-Chalmers Mfg Co and shipped to Elk River, Minn. The Saxton reactor will supply steam to existing turbine in Pennsylvania Electric Co's plant.

# Reserved for your comment

BOB BELLAS, Associate Editor

## Doing a good turn

We of the engineering staff at NISA headquarters have read Mr Peach's article with great interest (*Motor insulation is better than ever: new materials and methods pave the way, TD* report, Feb 1960, pp 61-66). Particularly so since it emphasizes the trend stressed by Admiral Rickover in his talk, "Application of insulation to the apparatus," at the recent Insulation Conference in Washington.

Norm Peach's article also points up the new factor in the application of insulation, the *considerable engineering skill and ability* that is now a necessity for the practical and economical design of all types of windings, and the need for more "Insulation and Winding Engineers" or "Insulation-Application Technicians."

From the technical papers and the way they were presented and discussed, it was quite apparent that men attending the Insulation Conference represented a top caliber of engineering ability. They had a complete technical grasp of all kinds and types of insulation materials, an intimate knowledge of all kinds of windings, both ac and dc, and the operating conditions that these windings and materials must be designed to meet.

At NISA we realize the tremendous burden that application of insulation to apparatus places on operators of modern electric-motor rebuilding shops. To ease this burden and as an educational aid to member shops, we are inaugurating a series of NISA Regional practical-technical seminars. In these, we will review present standards and materials. We are going to shoot for higher quality and more economical windings, our goal being Class F and H windings for all rebuilt electrical apparatus.

To reach all NISA members (some 1500) we will schedule at least ten seminars per year for each of our intended five projects, to be held in various parts of the U.S. and Canada. We might add that the major wire-insulation manufacturers and suppliers are quite interested in our program. It permits them to obtain factual on-the-job data on how their products are used or abused in application. Their representatives will be present at the seminars to offer constructive and corrective advice as to their products' use.

These NISA seminars will also present various winding details that have important bearings on the useful life of a winding. For example, there are at least six types of random-wound coils. Question is, which of these is best and should be used for most effective winding under a given set of conditions? It is details such as these that the NISA seminars will discuss and resolve into better standards for electric-motor rebuilding.

A C Roe, *Staff Engineer*
*National Industrial Service Assn*
*National Headquarters, St. Louis, Mo.*

## Dissertation on disjunction

The articles dealing with thermal-insulation materials and application techniques published in Power at periodic intervals are, naturally, a matter of considerable interest to us. They are excellent presentations of a subject that grows increasingly important in the power-plant field.

In this vein, I'd like to comment on the matter of thermal-insulation specifications. Admittedly, this is a subject that has been kicked around for a good many years and topnotch designers have the situation well in hand. However, with new engineering blood coming into the field each year, I feel that Power would do a real service to the younger people by swinging the spotlight back to what's involved in specifying thermal insulation.

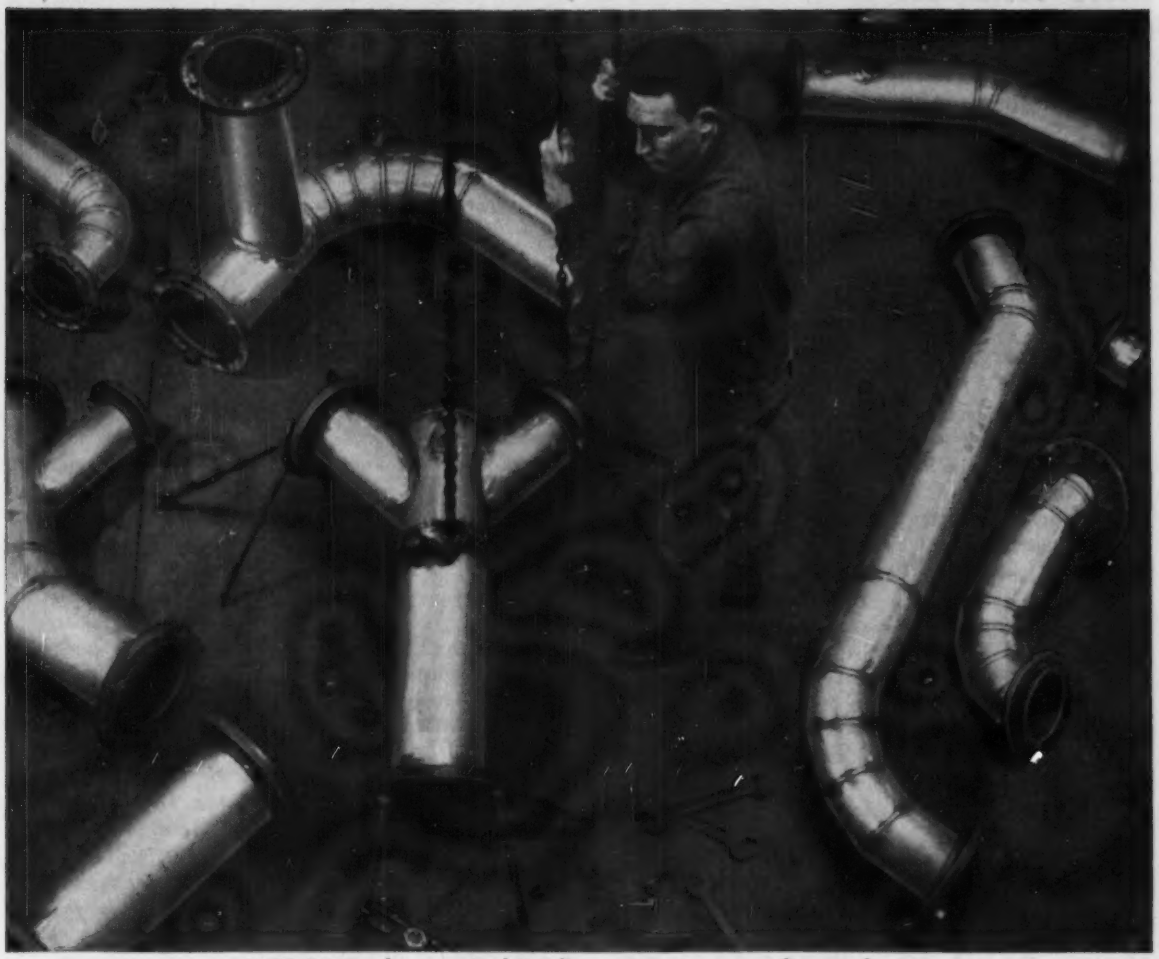
My point is that, in some instances, thermal insulation is specified by methods failing to produce operating savings that *could* be realized. In particular, specifying incorrect thickness impairs thermal efficiency at a time when costs are rising and each wasted Btu represents a greater loss.

Relying on surface temperature as the sole guide to insulation thickness is a pitfall to trap the unwary. Temperatures safe for personal contact are desirable and sensible in the right places, provide an easy basis on which to specify. But surface temperature was never intended to do more than assure personnel protection and serve as a rule-of-thumb measure of heat loss.

Shortcomings of the surface-temperature approach are well known. L B McMillan, in his classic paper, (*Transactions of the ASME*, Vol 48, 1926, "Heat transfer through insulation in the moderate and high-temperature fields: A statement of existing data") said that "probably no other conception in connection with heat transfer is so generally misued as this one."

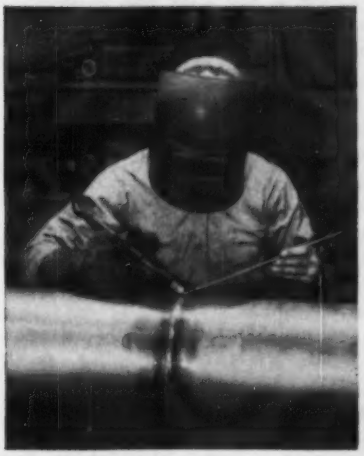
If an engineer relies on surface temperature, he is leaning toward what can be an extremely uneconomical practice. In some cases insulation will be too thin, resulting in wasted fuel, labor and other production factors needed to make up the lost heat. In other cases he may use so much insulation that the expenditure is not returned in heat savings within the specified amortization period.

Part of the responsibility lies in the fact that data supplied by insulation manufacturers have been



**CUPRO NICKEL** salt water circulating line sections to serve auxiliary condensers aboard gypsum rock carriers recently fabricated by Boro Marine & Industrial Corp.

# Wide variety of Cupro Nickel piping for salt water lines is readily made from sheet by welding



Circumferential joints are welded manually. Longitudinal seams are welded in mechanized equipment by inert-gas, metal-arc processes.

Ever higher velocities in salt water lines and the growing economic importance of continuity in service, on shipboard, and also in tidewater power plants and oil refineries, are leading to increasing use of Cupro Nickel in piping.

Techniques and skills for economical fabrication of even the most complicated elements of Cupro Nickel piping systems are keeping pace. Boro Marine & Industrial Corp., Port Richmond, Staten Island, N. Y., a specialist in the field, forms piping in sizes 6" to 24" diameter from Anaconda Cupro Nickel stock sheet, usually 48" x 96" x 3/16". Elements shown above indicate the variety possible. Seamless tubing is used for smaller diameters.

Boro Marine fabricates piping from both Cupro Nickel 30%-702 and Cupro Nickel 10%-755. The trend, however, is to Cupro Nickel 10%-755 for the majority of salt water line installations on commercial vessels and in industrial jobs, according to M. E. Wuensch, president. The alloy was developed by Anaconda for this kind of service. It is resistant to corrosion by both clean and polluted sea water, even at relatively high velocity of flow, and is resistant to corrosion by sea water containing air bubbles.

**TECHNICAL ASSISTANCE.** For help in selecting the alloy best suited for a particular job in heat transfer and piping systems, call in your American Brass representative, or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. mm

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For more facts circle 255 on Reader Service card, p 133

misconstrued. In their catalogs, our association's member companies publish sample recommended thicknesses of pipe and block insulations at different operating temperatures. But these recommendations apply only to one specific "average" set of conditions. To make this clear, NIMA is recommending to its members that all future catalogs carry this footnote to tables showing heat losses and surface temperatures: "Insulation surface temperatures are given only to indicate an approximate value for purposes of personnel safety, fire hazard, etc. They are theoretical values based on one set of conditions, usually in ambient still air (at a specified temperature). Actual surface temperatures vary widely depending upon the nature of the insulation surface finish, temperature and velocity of air over the surface, radiation to and from nearby objects, etc.

"Surface temperatures alone are absolutely no reliable indication of heat loss and therefore should not be specified nor used as a means of selecting the proper thickness of insulation. Since the major purpose for using thermal insulation is to save valuable heat energy, proper thickness should be based on economics. The *economical thickness* of insulation can be determined by comparing the value of heat saved by increasing increments of thickness and is that thickness the *last increment* of which will give the required return on the investment in *that increment.*"

There are several reasons why surface temperature alone is an unreliable method of measuring heat transfer. The same reasons show why data from catalogs do not correspond to actual surface temperatures under operating conditions:

**(1) Ambient-air** temperature is apt not to be sufficiently considered. If one wall of a boiler at a temperature of 135 F is exposed to air at 105 F, it will lose a small amount of heat. But another wall of the same boiler at 135 F exposed to air at 75 F will be losing heat in considerably greater quantity.

**(2) Air velocity** is so important that losses can vary over a range of several hundred percent at the same temperature difference, depending on rate of air movement to which the surface is exposed. Rate of heat loss from a surface 100 F above air temperature, exposed to air circulating at 400 ft per min (about 4½ miles per hr), is greater than for a surface 150 F above still air.

An adherent of the surface-temperature method who did consider air velocity in his calculations (that is, if he made calculations instead of taking his thicknesses from printed data sheets) could be neatly trapped in a way that illustrates the inaccuracy of the whole idea. Because circulating air lowers surface resistance, it reduces surface temperature. This could be deceiving to one whose sole criterion is surface temperature, for he could achieve that single result by specifying less insulation—in a high heat-loss situation.

**(3) Proximity** of hot or cold surfaces also has a noticeable effect on surface temperature as well as heat loss. Radiation loss varies according to the difference in the fourth powers of the absolute temperatures of the radiating surface and its surroundings. Thus a slight decrease in the temperature of an environmental surface produces a relatively great increase in radiation loss. As with the effect of higher convection loss, this reduces surface temperature of piping or equipment, creating another deceptive situation.

**(4) Emissivity** is another variable. Even though a bright, polished surface has a higher surface temperature than a dull surface, it might be losing heat at a rate only half as great. Another consideration in this respect is that some metals—copper, for example—have relatively low radiation losses when new, but loss increases in service as the surface becomes dull from oxidation. Oil and dust deposits also increase emissivity.

**(5) Other factors** tending to make surface temperature incomplete as a guide to heat transfer are roughness of surface, its shape and the direction it faces. While these variables will have relatively little effect on total heat transmitted by the insulation, they can have a disproportionate effect upon surface temperatures.

A relevant and important area tending to be completely ignored in the surface-temperature approach is that of economics: that is, the relationship between the cost of applied insulation and the cost of heat. This concept is the foundation of the economic-thickness approach to specs recommended by virtually all truly expert insulation engineers.

**Economic thickness** of insulation may be defined as the thickness of a given insulation that will save the greatest amount of heat while paying for itself within a given period of time. The amortized cost of insulation per year obviously increases as thickness does, but annual cost of heat loss decreases. Ergo, thickness at which the sum of these two costs is a minimum is the most economical and the one to be specified.

Obviously, this system requires that greater attention be given to specifying insulation than does arbitrary selection of a surface temperature, with thicknesses themselves taken from a table. However, a long series of calculations is not necessary. Standard reference works contain the basic economic-thickness equations, also offer numerous charts and tables, even a nomograph, from which economic thicknesses can be taken for all except the most abnormal applications.

**Surface temperature** properly comes into play after economic thickness has been determined. If final surface temperature is too high for personnel safety, then additional insulation can be used in specific areas where lower temperatures are needed.

J M Barnhart, *Executive Secretary*
*National Insulation Manufacturers Assn*

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TRANSMISSION & CHASSIS DIVISION—FORD MOTOR COMPANY
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# 95 years of design and manufacturing experience provides the basis for steam efficiency and economy at Ford plant

Three Keeler Type M K Steam Generators are serving Ford's Indianapolis Steering Gear & Cold Heading Plant with complete satisfaction on all points. They were selected for their ability to economically deliver 300,000-lb stm/hr for the plant's entire process, heat, hot water and auxiliary equipment requirements.

Two of the M K's are 120,000-lb stm/hr and the other is 60,000-lb stm/hr, 160 psi design pressure. They are equipped with air preheaters and spreader-stokers with continuous ash discharge, for bituminous coal firing—providing as modern and efficient a power facility as the manufacturing plant itself!

Keeler M K Steam Generators offer many efficiency and economy advantages! They are fully top supported, cross drum type with provision for downward expansion to eliminate any stresses being conveyed to the boiler proper, the steam piping or auxiliary equipment. Radiation losses are held to an absolute minimum with water cooled, completely steel encased and insulated furnace walls and roof.

*Write or phone for complete information* . . . Keeler M K's are available in capacities from 12,000 to 200,000-lb stm/hr—for high efficiency with any firing method or control system.

ONE OF THE NEWEST PLANTS in the Ford Motor Company's Transmission & Chassis Division, the Indianapolis Steering Gear & Cold Heading Plant is Ford's biggest producer of steering gear units for all company cars and trucks, and one of the largest cold heading operations in the world. The main building comprises more than 1,400,000 square feet of floor space—housing production, office and various employee facilities, including a fully staffed hospital and three cafeterias.

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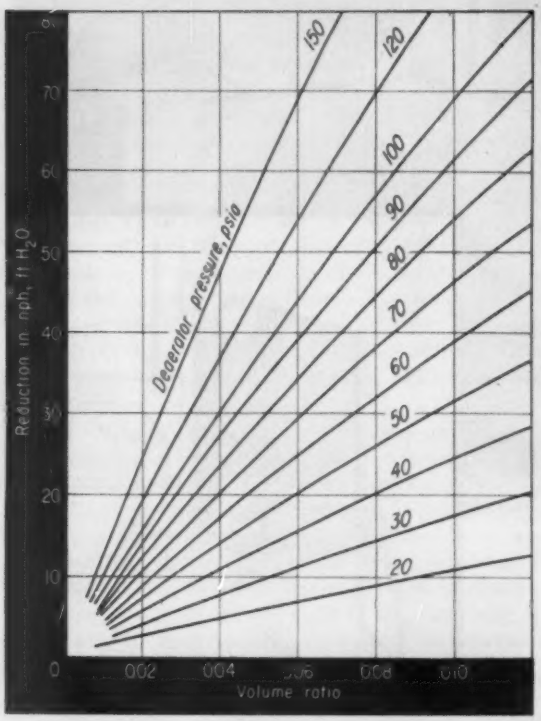
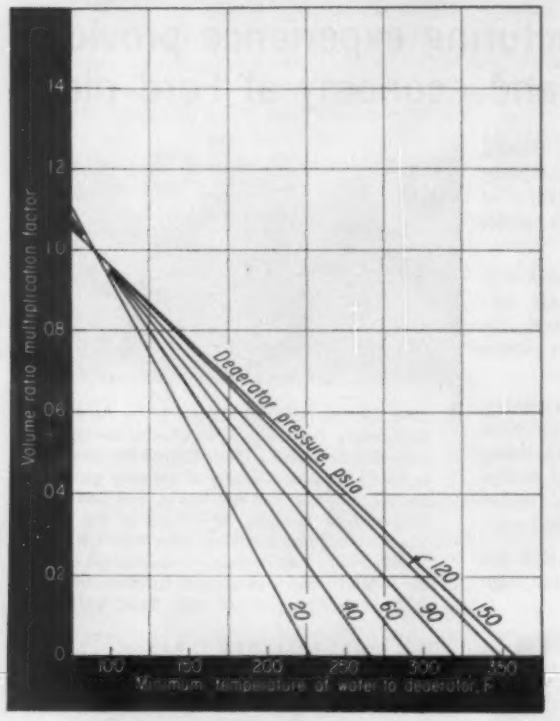
# Power's data sheet

No. 332




## Find feed-pump nph reduction due to rapid load decreases

Optimum size for boiler-feed-pump suction piping is a function of steady-state design conditions and a requirement for maintaining npsh to pump during transient conditions, such as full-load unit trip.

To check piping selection for transient conditions, curves at left may be used to estimate reduction in npsh available and possibility of flashing in the feed pump during sudden load reductions.

**Curves** as plotted are based on the following assumptions: (1) Flow into equals flow out of deaerator, and flow remains unchanged during transient period. (2) Water in deaerator storage tank is at the saturation temperature corresponding to deaerator operating pressure. (3) Effect of stored heat in steam contained in deaerator has been neglected. Calculations indicate effect of this stored heat does not appreciably affect calculation results. (4) Minimum temperature of water to deaerator should exceed value which can be maintained during entire transient period considered. This temperature should not exceed condensate temperature leaving air ejector or other heaters not affected by load reduction.

**Estimating procedure** involves calculating ratio of volume of water in feed-pump suction line to the minimum normal volume of water in the deaerator storage tank. Enter lower chart with values of minimum water temperature to deaerator and deaerator pressure to obtain volume-ratio correction factor. Then plot corrected volume ratio and deaerator pressure in the upper chart to obtain reduction in nph. Finally, npsh available to pump equals static head from pump inlet to deaerator storage tank's minimum normal water level, minus friction loss and nph reduction due to transient.

To check flashing in feed-pump suction line at any point X, recalculate volume ratio using volume of water in suction pipe between deaerator and point selected, and read nph reduction as before. Nph at point selected equals static head from deaerator minimum normal water level to point X, minus friction losses to that point and nph reduction. If nph is negative, flashing could occur.

P A Pasquet, *Niagara Falls, Canada*

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# in Disc Equipped Bronze Valves

**LOOK at that Wheel** — Tough malleable iron. Design unequalled for cool, sure grip.

**LOOK at the Index Plate** — Has Fig. No. etched in green background. Held by wheel nut which is secured by rolled-over spindle end.

**LOOK at that Spindle** — Made of high tensile bronze. See how much heavier it is . . . how many more deeply cut threads engage bonnet. And, the crowned head that reduces friction on disc holder. Sure, it costs more to make a spindle this way. But it reduces wear, preserves packing, means easier operation.

**LOOK at the Packing Nut and Gland**—Note the heavy and deep bronze hex. And, that bronze gland designed to compress packing toward spindle.

**LOOK at that Packing Box** — Its depth equals 1½ times spindle diameter. More packing space means less repacking. An asbestos, lubricated and graphited packing is used.

**LOOK at that Bonnet** — One-piece, screw-over design with big hex surfaces is easy to remove. Take an extra look at the bevel joint between bonnet and body, serving as an internal brace against the crushing effect of the bonnet assembly. Millions of Fig. 106-A in use for years prove this unique design licks distortion and springing.

**LOOK at the Disc Holder** — It's the Slip-on Stay-on type originated by Jenkins. Correct protective depth prevents flaking or cracking of disc.

**LOOK at the Disc** — Easily renewed without removing valve from line. Made of compositions to suit various services . . . and **made by Jenkins**, the only maker of both valves and discs.

**LOOK at that Body** — Just compare wall thickness of this high tensile bronze body with any other valve. The factor of safety is many times higher than rating requires. See the curved diaphragm to protect seat from distortion by pipe strain. Note that the raised seat is higher to permit more reseating operations . . . and wider, so it won't cut into disc. Pipe threads are full length and clean cut.

**LOOK at this . . . for Throttling** —Just replace the standard disc nut with this Throttling Nut and a Fig. 106-A becomes well-suited to throttling service. This unique nut reduces the effects of wire drawing and its long legs restrict flow for accurate control. Many plants take advantage of this versatile valve to reduce valve and parts inventory.

**THE FIRST** renewable composition disc valve was a Jenkins Valve, originated nearly a century ago. Compare today's Fig. 106-A Bronze Globe with any other. See why so many valve users agree that a *Jenkins* is still the FIRST for top value. For descriptive folder No. 189-B on the full line of Jenkins Bronze Globe, Angle and Check Valves write to Jenkins Bros., 100 Park Avenue, New York 17.

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# Technical briefs . . . Latest engineering

## Engineers and manufacturers discuss low-level economizer design and operation

**The low-level economizer,** *S Jewson, The Green Fuel Economizer Company*

Low-level economizers to recover heat from stack gas offer some increase in station efficiency. But problems of corrosion introduced are complex and vary widely with cycle and fuel burned. Formation and effects of $H_2SO_3$ and $H_2SO_4$ depend on temperatures throughout flue system. Several "safe" temperature ranges of operation exist but they are between temperature zones where severe corrosion is a problem. Ranges must be individually studied; they are not constant for all stations and cycles.

Low-level economizer design must provide for: (1) large heat-transfer surfaces because of small temperature differentials (2) large gas-passage areas to minimize plugging (3) high degree of acid-corrosion resistance (4) water-wash equipment to remove sticky flyash deposits and (5) equipment costs limited to added economy produced.

Cast iron is considered best for low-level economizers because of high corrosion resistance and low first cost. Minimum fin spacing should be one in. to prevent bridging. Economizers should be sectionalized, especially in single-gas-stream units. This permits water washing when unit is on the line without the added complication produced by gas flow during washing cycle. *ASME 59-A-226*

**Design performance of the low-level economizer,** *J H Potter, Stevens Institute of Technology and R C King, Gibbs and Hill Engineers*

Placing a low-level economizer downstream from the air heater in the flue-gas system offers several possible cycle improvements. But it does require special breaching and stack construction to resist corrosion with lower stack-gas temperatures.

As a replacement for steam coils to temper combustion air ahead of the heater, a low-level economizer shows greatest promise at low ambient temperatures. It can also substitute for an intermediate-pressure feedwater heater. Here greatest savings come under high ambient conditions.

Study includes operating effects of each application at various station loads, and construction details of the low-level economizer. *ASME 59-A-222*

**Heat-transfer performance of condenser tubes,** *J A Stawicki and J S Ungar, Consolidated Edison Company of New York*

Reductions in condenser performance can be very costly: a loss of 0.10-in.-Hg exhaust pressure can add $800 a month to 190-mw-unit operating costs.

Con Edison developed a special single-tube calorimeter to maintain a check on condenser performance and study unexplained changes in heat-transfer characteristics. Whenever comparison with an established bogey shows a significant loss of performance, a tube is withdrawn and tested. Heat-transfer rates before and after cleaning are basis for cleaning entire condenser. Variations in after-acid-cleaning performance reveal importance of proper acid temperature—160 to 190 F.

Tests show that resumption of chlorination after lengthy interruption does not restore tube performance completely. Mechanical cleaning also is required. Studies of initial fall-off in new condensers show that Al-brass tubes have best heat-transfer characteristics of materials tested. *ASME 59-A- 225*

**Flash evaporators for the production of boiler makeup in power-plant cycles,** *E F Stalcup, E F Coxe and R L Coit, Westinghouse Electric Corp*

Operating experience with flash type evaporators developed for sea-water distillation leads to their consideration in normal power-plant cycles. Equipment provided for the Shiekdom of Kuwait has operated over 7000 hr without cleaning. This performance is attributed to operating temperatures below 200 F and proper chemical treatment.

In power cycles, flash instead of single-effect submerged-tube evaporators offer several advantages: (1) lower temperature minimizes scaling (2) effective deaeration is accomplished by the evaporator and (3) turbine heat rate is reduced. For seaside power plants where fresh-water supplies are limited or costly, flash evaporation can provide large quantities of fresh service water as well as boiler makeup. Operating costs here are minimized by using condenser circulator outlet as heat source to operate flash evaporator. *ASME 59-A-203*

### Motors

**Characteristics of centrifugal pumps and compressors which affect the motor driver under transient conditions,** *H A Wiegand, Ingersoll Rand Co and L B Eddy, Universal Oil Products Company*

Reactions during transients on driving motors for centrifugal pumps and compressors depend on characteristics of hydraulic system and driven equipment. Basic transient considered is a momentary electrical interruption.

For centrifugal pumps, items to be considered are: (1) liquid-system characteristics, including division of total head between static and dynamic (2) pump inertia—$WK^2$ (3) pump characteristics based on specific speed—$N_s$ (4) method of pump control and (5) combined characteristics of pump

# developments for busy power men

and system acting together. Since momentary power interruption causes a partial stopping and re-starting, equipment operation on startup is discussed.

Compressor characteristics under similar conditions are covered in detail. Factors similar to pumps must be considered together with complications added by compressibility of fluid handled. Compressor-control methods are completely different from pump control. Many operating characteristics of centrifugal pumps and compressors during transients are graphically shown to illustrate the discussion. *AIEE 60-16*

**Survey of induction-motor protection,** *Subcommittee on Motor Protection of the AIEE Relays Committee*
Increased dependence by both utilities and general industry on reliability of large induction motors prompted this survey by the AIEE Subcommittee on Motor Protection. They feel that survey results are typical of today's motor-protection practices of large-motor users, since 12 representative industrials and 23 utilities answered the questionnaire.

Survey covered: (1) system grounding (2) protective devices used (3) settings (4) unwarranted operation of protective devices and (5) motor protection considered for new installations. Each item is discussed in detail and survey results are tabulated to show differences between utility and industry practice.

Wide variations in present practice indicated by the survey show need for motor protection application guide. This is the goal of the subcommittee. *AIEE 60-32*

**Equivalent circuits and performance calculations of canned motors,** *P D Agarwal, University of Mass.*
New equivalent circuits and procedures are given for performance calculations of canned motors. These include speed, torque and current curves and stray losses of induction motors having solid-steel rotors and slot-imbedded squirrel-cage bars.

Test results confirm this method when applied particularly to canned motors. It must, however, be applied to several motors to prove results. *AIEE CP 60-165*

## Corrosion

**Corrosion of water-treatment plants, F O Water,** *San Diego Utilities Department*
A cathodic-protection system installed at the Alvarado Filtration Plant of the City of San Diego provided considerable data on corrosion reduction. Cathodic-protection methods used at several points within the plant produced varying results.

In the settling basins where over 13,000 ft of moving chain was to be protected against corrosion, long-term results are satisfactory. Accelerated tests were run on many types of insulation. While most materials tested gave unsatisfactory results, first layer of rubber putty and a final layer of polyvinyl tape tested out best and is in current use.

Cathodic protection in the pressure filters presented a problem of scale formation on the bed. Corrosion ceased with a potential of 1.1 v with respect to a copper-sulfate electrode, but calcium started to precipitate at 1.8. *Western Regional Division, NACE, Sept 1959*

## Gas turbines

**Experiences with gas turbines in French power stations,** *P Chambadal, Electricité de France*
In 1953 and 1954, Electricité de France (the French national power company) ordered five 6000-kw gas turbines for peaking service. Each is of a different design and make to provide economic comparisons. Each set has a reactive capacity of 10,000 kva and is normally operated as a synchronous condenser when not peaking. This duty set machine size.

Installations are described in detail. In several stations free-piston gassifiers are used with the turbines. Comparative fuel-burning characteristics are discussed. Cheap heavy oil is burned wherever possible; pretreatment and heating are covered.

Operating experience has been excellent in all cases and a high degree of reliability has been achieved. *ASME 60-GT-1*

**25,000-kw Mene Grande gas-turbine installation,** *C M Honaker, Mene Grande Oil Co and D F Bruce, Westinghouse Electric Corp*
In the early 1950's Mene Grande Oil Company started work on a $12,000,000 gas-turbine central power station in Eastern Venezuela. Station and system are electrically isolated and consist of five 5000-kw gas-turbine-driven generators — the last installed in 1959.

Choice of gas-turbine prime movers was based on low first cost, low water requirements and low operating and maintenance costs.

By mid-1959, station had operated 39,000 hr (118,500 machine hr) and generated 264,268,000 kwhr at a unit cost of $0.00957 per kwhr. Station design, including turbine details, is discussed. Original evaluation between steam turbines, internal-combustion engines and gas turbines is given to show basis of prime-mover selection. Maintenance and operating costs are broken down to show basis of cost per kwhr given. *ASME 59-A-191*

continued

Directions for ordering these papers on page 142

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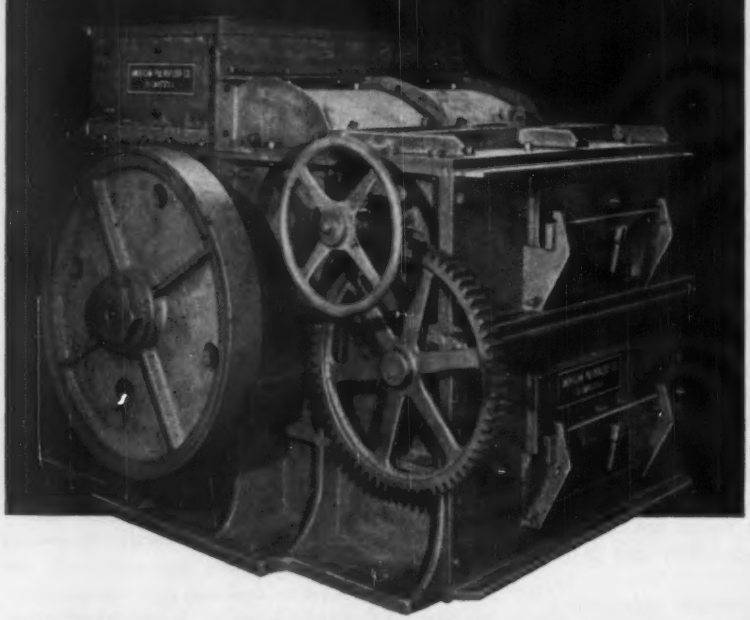

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## Technical briefs

Begins on page 120

**The application of internal-gear rotary pumps to viscous-liquid service,** *S L Fry, L H Kessler and S E Kotz, Fairbanks Morse & Co and R J Kinnavy, The Deming Company*
Internal-gear rotary pumps have been used for many years to handle highly viscous liquids. Past practice of reducing speed with increased viscosity to minimize hp losses has necessitated use of larger and costlier pumps.

Several liquids of representative viscosity (water, solvent and SAE oils No. 20, 50 and 250) were tested with varying internal pump clearances. It was found that hp input decreased with increased clearance.

Hence for a given set of operating conditions (flow, pressure and viscosity) an optimum clearance exists in each slip path of the pump. For example, in the design of an 8-in. pump, 76% efficiency was obtained on water with a 0.010-in. clearance and 84% on Bunker-C fuel oil (at 120 F) with an 0.030-in. clearance. *ASME 60-HYD-1*

**The approximate determination of the optimum cycle for 2-circuit atomic-power stations.** *Yu D Arsen'yev and Ye K Averin, Power Institute, Academy of Sciences, U.S.S.R.*
In 2-cycle atomic-power plants, many intermediate temperatures are possible with fixed maximum and minimum cycle temperatures, but only one intermediate temperature gives maximum cycle efficiency. Practical engineering considerations, however, frequently override theoretical considerations and alter the actual intermediate temperature.

Formulas are set up to determine optimum cycle characteristics and fuel costs using accepted simplifying assumptions. The derivation assumes that fuel cost per kwhr of thermal output is constant. Actually, this is not true with enriched uranium.

Examples of calculations illustrate best choice of cycle temperatures and confirm approximate formulas derived. *Teploenergetika 1959, No. 5 (5 pages)*

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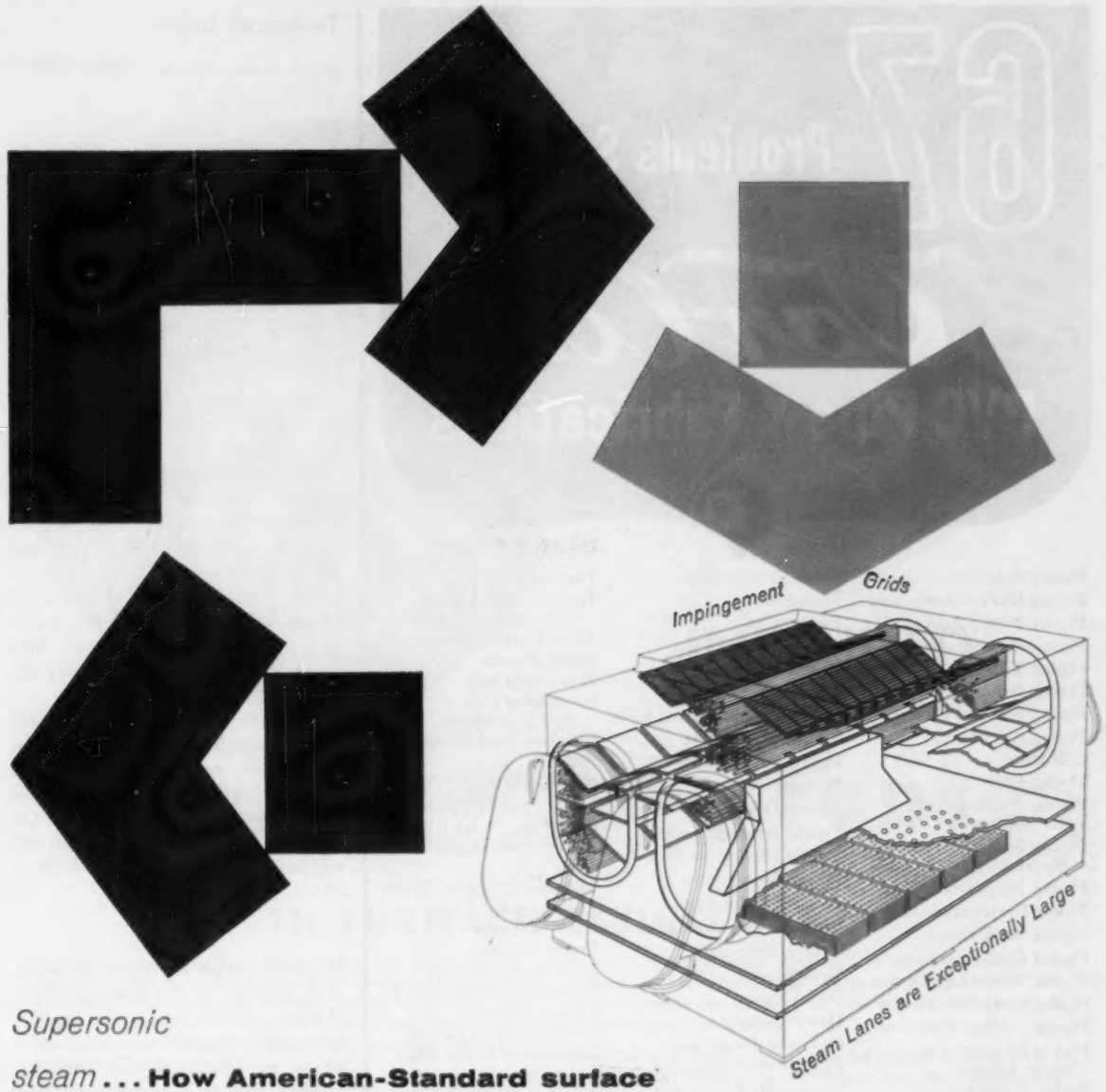


## *Supersonic steam* . . . How American-Standard surface condenser design guards against erosion

Wet steam from the turbine may enter the condenser at supersonic speeds—up to 1200 feet per second. Entrained moisture particles strike like rifle bullets . . . can erode unprotected tubes to quick failure. Impingement grids, standard equipment in every American-Standard* Surface Condenser, deflect and slow down these moisture bullets. Wide steam lanes reduce steam velocity to 100 feet per second, or less. This is why our surface condensers serve for years without tube failure from impingement erosion. Be sure you have all the story. Write for Bulletin 8.2k1. American-Standard Industrial Division, Detroit 32, Michigan. In Canada: American-Standard Products (Canada) Limited, Toronto, Ontario.

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# 67 Problems Solved by Van-Cor PVC Pipe & Fabrications

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Piping Chicken feed
Piping Demineralized $H_2O$
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## Technical briefs

Begins on page 120

**A new sensitive temperature detector for use in high-pressure fluid piping,** *D Robertson, Leeds & Northrup Company*

Today's high steam pressures and temperatures necessitate very heavy-walled piping in modern generating stations. Thus rapid determination of steam-temperature changes becomes increasingly difficult. Due to pressures and stresses, it is impractical to insert thermocouples directly into the steam flow.

New method involves three thermocouples connected in series. Center thermocouple is located a known distance from inside pipe surface, and the other two are at half of this known distance. Effect of this series arrangement is to electrically invert temperature indication. Thus actual inside wall temperature is closely followed.

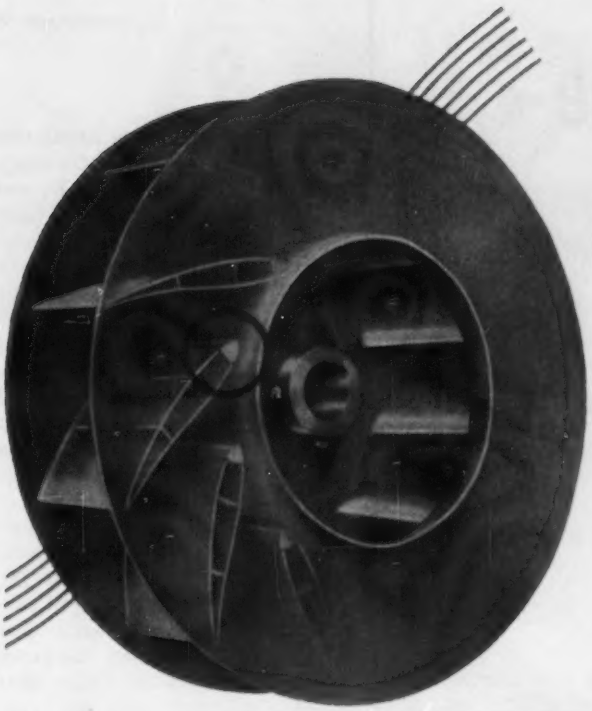
Extensive laboratory and field studies show high degree of temperature-change response possible. In field applications, accuracy may be slightly reduced due to pipe-mill tolerances but probably still will be well within required limits. *ASME 59-A-201*

**Magnetic type mechanical seals,** *A W Lighter, A W Chesterton Co*

Mechanical seals for rotating machinery require considerable axial space where springs hold seal faces together. Use of Alnico-5 permanent magnets to replace mechanical push of springs greatly reduces required seal space. Also, elimination of precise spring setting and adjustment reduces chance of installation error. O-ring seals between rotating seal parts and shaft and provides friction drive.

Seal gland must be of nonmagnetic material such as brass or series: 300 stainless steel. Since length of carbon-seal face protrusion affects magnetic forces, use where wear is high because of nonlubricating fluids requires special consideration. Where problems of iron corrosion exist, a heavy rhodium plate can be applied to the Alnico magnet. *ASME 59-PET-35*

continued



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## Green Airfoil Fans

## IN FURNACE REBUILDING

At their #2 plant in East Chicago, Indiana, Inland Steel completely rebuilt and enlarged their furnaces to increase production. These rebuilt furnaces called for greater induced draft capacity in the waste heat boilers. The old fan installation of 7 Green radial blade fans had been installed 24 years ago.

Inland Steel replaced these 7 Green fans with 7 Green AIRFOIL induced draft fans. No changes were made in the original motors or electrical system. The 7 Green AIRFOIL fans took care of the increased draft requirements without overload on the original 125 hp motors.

In short, the new Green AIRFOIL fans made it possible for Inland Steel to increase the size and capacity of their furnaces without the expense of new motors and electrical installations in addition.

The Green AIRFOIL design provides smooth airflow with a minimum of turbulence. For longer life, the AIRFOIL fan blades have specially designed cast steel nose pieces to reduce wear. (See circled nose piece in illustration.)

If you have a tough job for heavy duty fans, it makes sense to talk over your problem with Green.

Green

THE GREEN FUEL ECONOMIZER CO., INC.,

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For more facts circle 261 on Reader Service card, p 133

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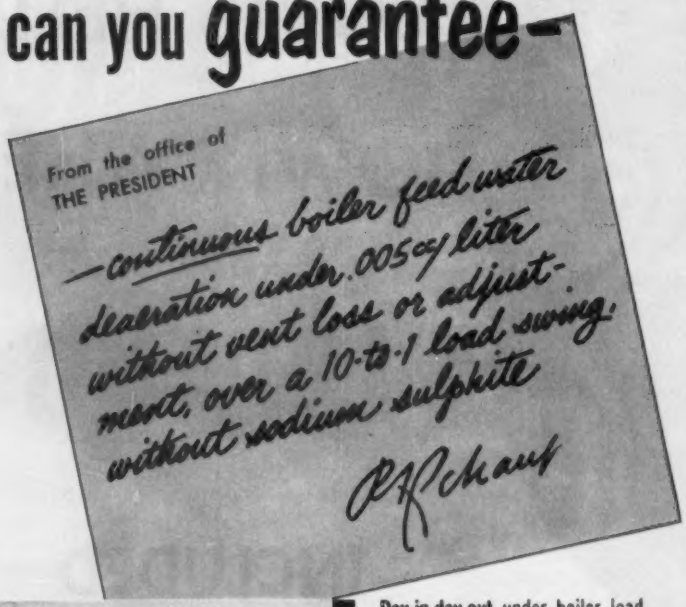
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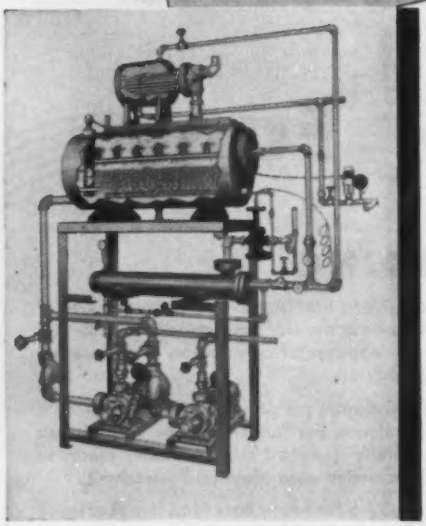

**Day-in-day-out** under boiler load swings as great as 10-to-1—**not** just under favorable fixed test conditions.

**Excellent thermal efficiency** (insignificant steam vent loss) under **all** regular operating conditions—with no vent adjustment for any load change.

**No need for sodium sulphite** or other additives. (If you need 'em, you just aren't getting full mechanical deaeration).

**Plus at least 6 other savings** in operations, maintenance and installation.

**All are the result** of the unique, but 15-year proved, Schaub design for external superheating, explosive flashdown and fully-vented operation.

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## Technical briefs

Begins on page 120

**Training on a process simulator, Parts I and II,** *E O Carmody, Carmody Corp, Buffalo, N. Y., and F L Lichtenfels, Standard Oil Company of Ohio*

A training process simulator is a mockup of an actual control room and provides problems to be solved by trainees. Savings in training costs result from pretraining (before actual installation is complete) and presetting problems to suit training program rather than depending on system operation to provide suitable problems.

Process simulator (1) places operator in training situation physically duplicating operating situation (2) activates many instruments and controls from instructor's console and (3) sets up normal and emergency situations to which the trainee must respond correctly.

Particular training simulators discussed pertain to petrochemical industry. But training in modern power-plant control-room procedures uses same basic principles. *ASME 59-A-218* and *-205*

**Small free-piston engine-compressor,** *J H McNinch, W W Vogelhuber and R J McCrory, Battelle Memorial Institute*

This small free-piston engine-compressor is specifically designed for air-conditioning systems of about 3-ton capacity. But application in other similar services is practical with a minimum of modification.

Basic machine consists of spark-ignited Otto-cycle power cylinder and compression cylinder with intermediate bounce chamber. Of necessity a 2-cycle design, it is provided with a pneumatic fuel (gas) injector. Since energy is transmitted to compressor without intermediate mechanical linkage, vibration is extremely low when unit operates at rated speed of about 1500 cycles per min.

Characteristics of full-sized engine-compressor are given at various compression ratios and operating details of auxiliaries (fuel injection and scavenging) covered. *ASME 59-A-97*

continued

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Part-for-part, O-B union bonnet gate valves are made to give the longest, most reliable service.

Handwheels are cast of tough aluminum alloy to withstand the strongest grip.

Stems and discs are cast or machined from a special copper base, high tensile, high yield strength bronze developed for excellent resistance to corrosion.

Bonnets, union rings, bodies and other cast parts are made of bronze 85-5-5-5 (ASTM B61) with plenty of weight for durable service.

Because of the care Ohio Brass takes in the manufacture of individual parts, valves last longer and need less maintenance.

O-B rising stem union bonnet gate valves are available in sizes from ¼-through 3-inches in pressure ratings of 125 lbs. WSP - 200 lbs. WOG and 150 lbs. WSP - 300 lbs. WOG. Ask your distributor about all O-B bronze valves, or write to Ohio Brass Company, Mansfield, Ohio.

For more facts circle 263 on Reader Service card, p 133

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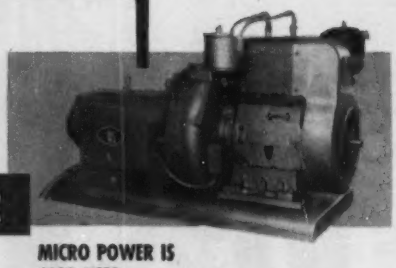
*assures effectiveness of its protective boiler flame controls with . . .*

**MICRO POWER**



In plants like Douglas Aircraft Company, Inc., in Tulsa, Oklahoma, where a continual supply of steam is vital to production processes, every precaution must be taken to assure against the hazards of boiler flame-out. To safely regulate its burners in the event of flame-out, the company utilizes highly sensitive electric controls. Since these flame failure controls *are* electric and must depend on a constant, unwavering power supply for successful operation, this is achieved with MICRO POWER.

At Douglas Aircraft in Tulsa, Micro Power serves as the dependable rear guard to the boiler room. It provides a constant source of steady, independent electrical power as required by the safety controls, thereby eliminating voltage fluctuations and protecting against power failure.

**MICRO POWER IS ALSO USED . . .**

- on microwave systems for communications, for remote control, for telemetering.
- for refinery and chemical process indication and control.
- by public utilities through microwave for protective relaying, telemetering and load distribution.

**MICRO POWER PROVIDES . . .**

- a constant uninterrupted source of electric power.
- voltage and frequency at usable value during transfers between motor and engine.
- stable voltage output.
- flywheel starting — no storage batteries.
- electrical isolation from commercial source — voltage dips, peaks and breaks do not affect microwave equipment, no transfer switch.

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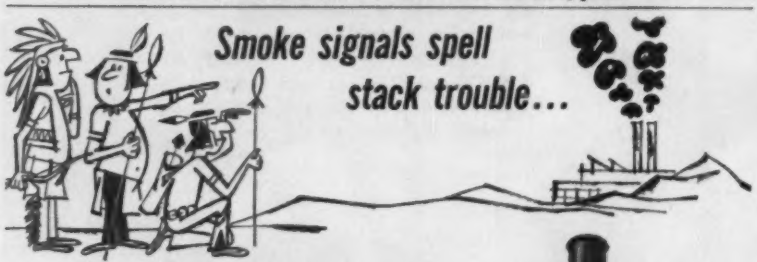


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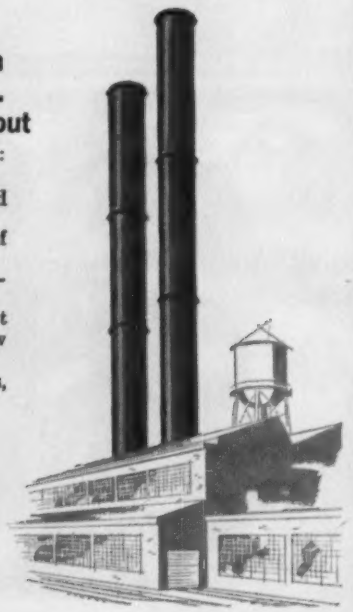

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## Technical briefs

Begins on page 120

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National Association of Corrosion Engineers. Reprints will be available after publication in *Corrosion*. Contact NACE, 1061 M & M Building, Houston 2, Texas. Prices not established.

Russian papers. For complete English abstracts contact Office of Technical Services, U.S. Dept of Commerce, Washington 25, D.C. Price, 70c. For complete papers in Russian contact Chief, Photoduplication Service, Library of Congress, Washington 25, D.C. Price, $1.80 for 1 to 10 pages.

### Correction

In Feb 1960 *Technical briefs*, p 101, "Operating experience and advance designs of sodium-graphite reactors," we should have said that *power generation costs* were about 7 mills per kwhr for the 255-mwe plant and about 5.4 mills per kwhr for the 540-mwe plant. Actually, *fuel costs* for the plants are estimated at about 1.7 and 1.6 mills per kwhr respectively.

---

**Water used in U.S.** in 1959 reached 300 billion gal per day, according to Nalco Chemical Company; 46% was for industrial and power-generating purposes.

**Siberia's total fuel** and energy resources are estimated at 1,271,000 million metric tons—71% of total U.S.S.R. fuel and energy resources. Siberia possesses 76% of all Soviet fuel resources and 54% of all hydropower resources.



**For more facts circle 265 on Reader Service card, p 133**

**circle 266 on Reader Service card, p 133**

*Just 75 years ago, heating was about as unpredictable as the weather, as temperatures alternated between shivery low and smother-high. Then a Wisconsin schoolteacher named Johnson decided to do something about classroom comfort and thereby launched a new industry!*

# The Story of the Thermostat

Actually this is the story of a symbol . . . the symbol of an industry that has brought comfort, safety, better health, and efficient working conditions to people all over the world.

. . . In a specially equipped manufacturing plant, delicate missile parts and components, with micro-inch tolerances, must be made under temperature and humidity conditions that never vary. At every step in their manufacture, modern pneumatic controls assure error-free regulation of the thermal environment.

. . . In a hospital, surgeons perform a lifesaving operation. Accurate pneumatic controls maintain the temperature and humidity at preselected levels to conserve the patient's strength during surgery.

. . . Every morning of the school year, millions of students sit down to study and learn in comfortably heated and ventilated or even air-conditioned classrooms. To help provide this ideal environment, the great majority of schools and colleges everywhere depend on precision pneumatic control systems.

. . . Far at sea, one of the nation's deadly new submarines cruises undetected, an elusive, power-laden sentry of the "Silent Service." Her crew lives and works in comfort and safety — in a climate precisely regulated by a pneumatic control system.

. . . Across the continent, pneumatic controls assure safe air conditions in the highly critical processing areas of an atomic energy facility. Pneumatic controllers of extreme sensitivity operate constantly to assure safe disposal of waste air and prevent the escape of contamination.

These are but a few examples of the ways in which modern pneumatic controls play a vital part in regulating the environment in which we live and work — helping to create made-to-order indoor climate for every purpose, controlling temperatures and humidities to a degree undreamed of when Professor Warren S. Johnson invented the first automatic temperature control system back in the 1880's.

## Inventor at Work

Though he was probably unaware of the fact at the time, Professor Johnson became the founder of the automatic temperature control industry when he devised a practical way to eliminate the problem of classroom temperatures that seemed to zigzag forever between shiver and swelter.

His first attempt at control — the "annunciator" system — merely called the janitor's attention to overheating, or lack of heat, by ringing a bell in the furnace room. The janitor would then open or close the classroom dampers, as required.

But this land-based version of a ship's telegraph soon gave way to an all-electric method, utilizing a thermostat in each room that would open and close the dampers automatically. And so, the first system of automatic heat regulation was born.

## The Electro-Pneumatic System

Intrigued with the possibilities of his long-awaited discoveries, Professor Johnson in 1883 left his post at Whitewater, Wisconsin, State College and came to Milwaukee to devote full time to refining and marketing the Johnson System.

His second major achievement, an electro-pneumatic control system, occurred almost at once. By successfully uniting the forces of *electricity*, for thermostat operation, and *compressed air*, for valve and damper operation, he developed a far more dependable and fully automatic control system. Finally he was ready to go out and revolutionize the comfort standards of the world. In 1885, he incorporated the business which today bears his name.

With branches established in Chicago, St. Louis, and New York, the Johnson thermostat on the wall soon became a familiar sight in the leading buildings of the day. Schools, prominent residences, and small business buildings were first to enjoy the comforts and economies of automatic control. They were followed closely by colleges, hospitals, public buildings, offices, stores, and industrial plants.

## From Mikado to Czar

Acceptance grew, markets widened. The fame of automatic controls traveled fast and far. Before 1890, the city of Berlin, Prussia, had written a report about the efficiency of its Johnson System. Later, the palace of the Mikado in Japan was equipped with Johnson Control. The King of Spain and other European royalty became Johnson customers. A special installation was made in the Kremlin in Moscow!

## Single Responsibility

Professor Johnson had the foresight to realize that the key to his success depended upon the *proper application* of his controls. Accordingly, he determined, from the outset, that his company should *never sell devices*, but should sell a *principle of control*. This meant that each system would have to be planned, manufactured, installed, and serviced *by Johnson* to meet the exact needs of the individual building.

Over the years, this policy of complete responsibility by a single specialized organization has insured owner satisfaction and saved untold millions of dollars for Johnson customers.

Carrying out this policy has also resulted in the closest possible working relationship between the Johnson organization and the nation's consulting engineers and architects, in a joint effort to provide ever better control of thermal conditions.

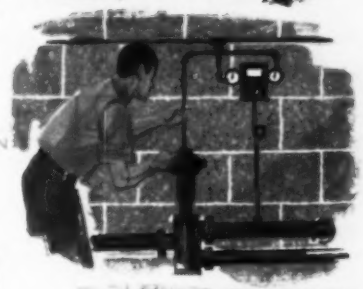
## Many Johnson "Firsts"

The history of the thermostat and the Johnson Service Company coincides with the period when other pioneers were busy introducing innovations in heating, cooling, and ventilating methods and in developing full-scale air conditioning. Working closely with the research staffs of these manufacturers, Johnson engineers were able to supply the most effective controls for every new development in basic equipment. This cooperation has continued and flourished to the present.

Over the years, the Johnson Service Company has been the source of a never-ending flow of new ideas, which have included virtually all of the key developments in the field of automatic temperature control!

By far the most important was the all-pneumatic control system, perfected in the 1890's and still the standard everywhere. Others include the all-metal thermostat, the famous *Dual* or day-night thermostat, the heating-cooling thermostat, summer-winter thermostats, the airstream thermostat, master-submaster thermostats, supersensitive gradual-acting thermostats, and powerful piston damper operators.

Another famous development was the Humidostat or humidity regulator. And, of course, the Comfostat, an exclusive Johnson instrument that controls room temperatures in relation to humidity conditions. The popular pneumatic control center, for centralized supervision and control of modern air-conditioning systems, also was first perfected by Johnson.



## Uninterrupted Progress

As the concept of controlled environment gathered momentum, so did Johnson. Important "firsts" became routine jobs, as the industry looked to Johnson for the answers to new control problems. From the simple comfort needs of the buildings of the 80's and 90's, to the history-making demands of the first scientifically air-conditioned building, down to the most complex requirements of today's commercial and industrial buildings, Johnson has been the leader in the pneumatic temperature control field.

Today, wherever you go, you'll find the important buildings are equipped with Johnson Control. From the fabulous Fontainebleau Hotel to the mammoth Merchandise Mart to the famous UN Secretariat Building . . . in schools, hospitals, sprawling defense plants, research laboratories, vital military installations, shopping centers, in buildings of *every* size and type and in ships at sea . . . there are temperature and air-conditioning control systems by Johnson.

## Johnson Today...and Tomorrow

To make certain that each installation performs up to expectations, Johnson backs its engineers with the most complete line of pneumatic temperature, humidity, and pressure control equipment in the industry.

To serve you most efficiently both before and *after* a sale, Johnson maintains the largest and most experienced field organization in the industry, with 107 completely staffed branch offices in the United States and Canada, plus full-time, factory-trained installation and service mechanics in over 200 other cities.

This is by no means the end of the story of the thermostat. For against this unmatched background of innovation, experience, and service, Johnson's never-ending search for new and better controls will inevitably lead to dramatic new ideas in the years ahead. As the day of completely air-conditioned cities approaches and as new and unprecedented demands for precision controls evolve, the forward-thinking Johnson organization will always be ready with the right answers.

The Johnson research and development staff and facilities have been expanded three times in the past four years. And final plans for the next major expansion are already underway! In the future then, as in the past, you can continue to look to Johnson for the world's finest controls!

Johnson Service Company, Milwaukee 1, Wisconsin. In Canada: Johnson Controls Ltd., Toronto 16, Ontario.

**JOHNSON CONTROL**

PNEUMATIC SYSTEMS

DESIGN • MANUFACTURE • INSTALLATION • SINCE 1885

AD 1073

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# Your service center for FREE data

Either of the no-postage Reader Service cards below and p 133B will bring you information on any new equipment listed or product advertised, plus new literature for your files

- **Study New Equipment** described in this issue starting on p 148. Circle numbers on card corresponding to items listed
- **Check New Literature** available this month beginning on p 133A. To get your personal copies use the card below
- **Read advertisements** and note number listed under each ad. Circle ad numbers on card for complete details
- **Print your name and company on front of card**

April 1960 issue **Circle numbers below for FREE data** Card void after July 1, 1960

**PLANT EQUIPMENT in the news this month, starting on p 148**

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
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51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75
76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

**NEW LITERATURE listed in this issue, starting on p 133 A**

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**ADVERTISED PRODUCTS appearing throughout the issue**

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**SEARCHLIGHT SECTION for used and rebuilt equipment, starting on p 263**

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# New free literature

### METALS AND MATERIALS

**101** **Solid urethane,** a rubber-like material, is topic of 4-p brochure. Dayton Rubber Company

**102** **Technical cements** and bonding compounds are listed with prices in indexed data sheet. Sauereisen Cements Company

**103** **1960 silicone-products guide** lists product uses and benefits. Section is devoted to silicone rubber and silicone-rubber compounds. General Electric Company

### COMPRESSORS

**104** **Stationary compressor** is topic of 24-p bulletin WN-114. Specs on three basic models of semiradially constructed units ranging from 1385 to 1948 cfm at 125 psi are included. Joy Mfg Company

**105** **Stationary air-compressor** line is detailed in 4-p folder. Units deliver up to 19,400 cfm at 100 psi. Atlas Copco

### MATERIALS HANDLING

**106** **Vibrating feeders,** motorized counterweight type, are featured in 12-p book 2369. Illustrations and descriptions of 60 sizes are given. Link-Belt Company

**107** **Car shaker** for unloading granular material from open hopper cars is topic of leaflet 26B9528. Unit weighs 3½ tons. Allis-Chalmers Manufacturing Co

**108** **Screw conveyors,** feeders and components are comprehensively reviewed in 76-p book 2989. Application and selection data is included. Link-Belt Company

**109** **Hoists, hoist cranes** are featured in 4-p bulletin with specs included. Northern Engineering Works

**110** **Wire-rope weights** and strengths are discussed in 4-p bulletin 6025. MacWhyte Wire Rope Co

**111** **Roller chain** and sprocket line is detailed in 56-p booklet. Photos and diagrams show construction details. Selection data and price list are given. Dodge Manufacturing Company

### ELECTRICAL GENERATION TRANSFORMATION AND CONVERSION

**112** **Gasoline-engine-driven** electric-generating plants are topic of 4-p folder. Specs for both air-cooled and water-cooled units are given. D W Onan & Sons, Inc

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**113** **Power-center planning guide** includes drawings, dimensions, weights, performances of basic units of load-center transformers. Standard transformer arrangements for use with switchgear and other equipment are discussed. R E Uptegraff Manufacturing Company

**114** **Medium transformers,** 501- to 5000-kva single-phase and 501- to 10,000-kva 3-phase units, are detailed in 32-p revised bulletin GEA 6108C. General Electric Co

**115** **Transformer** with current ratings from 1200 to 5000 amp for outside or inside use is featured in catalog sheet. American Gage & Machine Co, Standard Transformer Co Div

**116** **Silicon zener diodes,** hermetically sealed types, are topic of bulletin SR-260. International Rectifier Corp

**117** **Selenium or silicon rectifier** station type battery chargers are covered in 4-p brochure. Models range from 15 to 200 amp. Syntron Company

**118** **Industrial power units,** rectifier type operating from 115 or 230-v ac, are listed in bulletin 115A. The Cpad Electric Co

## ELECTRICAL DISTRIBUTION AND PROTECTION

**119** **Fuse ratings** for distribution duty based on AIEE specs are listed in bulletin 205. S&C Electric Company

**120** **Plug-in limit switch** with 2-circuit double-break switches is topic of catalog 301LS1. Minneapolis-Honeywell Regulator Co

**121** **Toggle switches** and assemblies are featured in 32-p catalog 73d. Minneapolis-Honeywell Regulator Company, Micro Switch Div

## ELECTRICAL APPLICATION

**122** **Emergency floodlighting** is topic of 16-p catalog. Stonco Electric Products Company

**123** **Insulating materials** for electrical equipment are covered in 12-p handbook GET-2929A. Characteristics and applications are described with tables. General Electric Company

**124** **Quartzline lamp holders** are topic of catalog sheet. The Miskella Infra-Red Company, Lighting Equipment Div

continued

April 1960 issue **Circle numbers below for FREE data** Card void after July 1, 1960

**PLANT EQUIPMENT in the news this month, starting on p 148**

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NEW FREE LITERATURE continued.....circle key numbers, page 133, for your copies

## INSTRUMENTATION

**125** **Rheostats,** carbon-pile, screw drive and switchboard types, are covered in well-illustrated 12-p booklet. Specs and selection info are given. James G Biddle Co

**126** **Recorder** designed especially for differential transformers is announced in data sheet 794-1. Houston Instrument Corporation

**127** **NEMA's 18-p Standards** Publication covers definitions, terminology and performance-measuring instruments pertaining to solid adsorbent type air and gas dehumidifying and dehydrating equipment. Gas Drying, Inc

**128** **Electric round-chart recorder** and controller is featured in 4-p bulletin GEZ-3969. Features, application, dimensions and list of available charts and scales are given. General Electric Co

**129** **Ac and dc h-v test stations** are discussed in practical hi-pot-testing reprint. Associated Research, Inc

**130** **Flow regulator** for replacing steam traps on veneer, paper and corrugated dryers is introduced in bulletin 600. Stickle Steam Specialties Company

**131** **Transistorized signal injector** for testing is featured in 2-p bulletin. Don Bosco Electronics, Inc

**132** **Spring-loaded thermocouple** adapter is detailed in spec sheet 2A. Thermo Electric Company

**133** **Sample-testing meters** are informally discussed in 20-p booklet GED-3613. Acceptable accuracies and economic feasibility of meter testing are covered. General Electric Company

**134** **Ultrasonic thickness testers,** lightweight portable models, are detailed in 8-p bulletin A-200. Branson Instruments, Inc

**135** **Light-sensing level-indicating** system for controlling levels of opaque and solid materials is described in 4-p bulletin E-200. The Euclid Electric & Manufacturing Company

**136** **Unit for continuous measurement** of $O_2$ in gases is featured in 2-p bulletin 1059. Milton Roy Co

**137** **Metallic-sheathed thermocouples** and extension wire, oxide insulated, are announced in 4-p cat-

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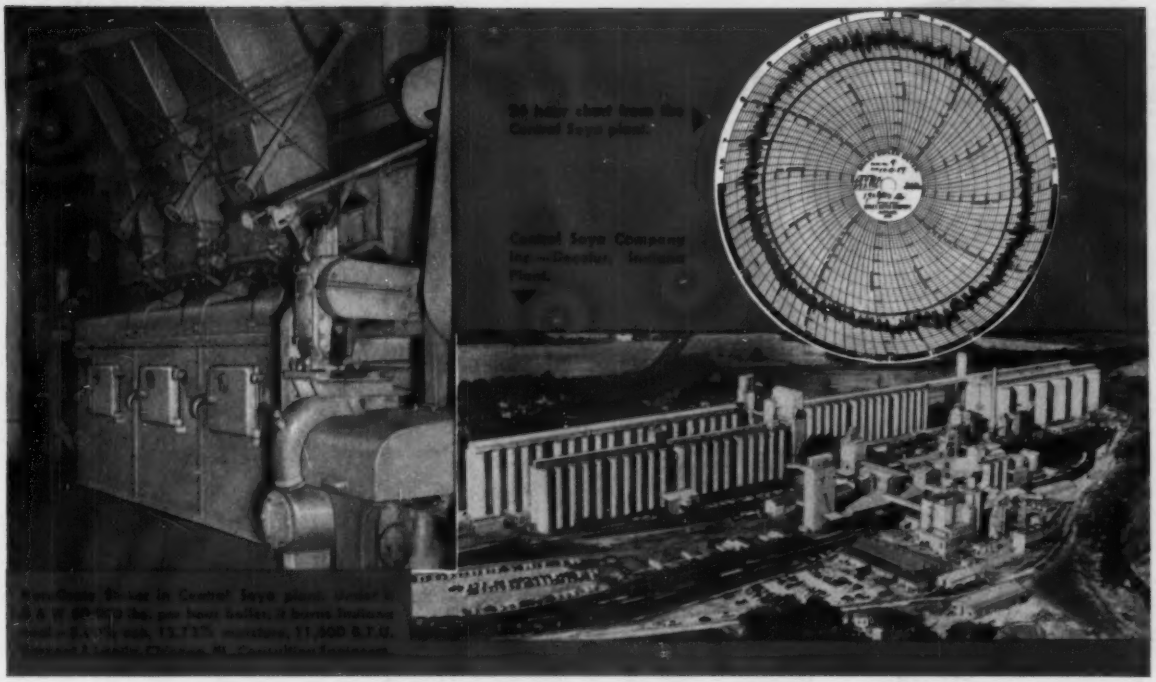

*8 Years of Stoker Operation*
*Without Forced Outage*

# DETROIT ROTOGRATE AVAILABILITY AT CENTRAL SOYA COMPANY INC.

Hersel Nash, Steam Power Superintendent of Central Soya Company, Inc., Decatur, Indiana Plant says: "Our 80,000 pounds per hour, 600 psig boiler with Detroit RotoGrate Stoker has carried loads similar to the accompanying chart for 355 days per year for eight years (we have the boiler down for inspection and cleaning once each year, for about 10 days.)"

"During this time we have burned about 300,000 tons of Indiana coal without ever losing the load because of the stoker. Our monthly efficiencies average 85% to 86%. This is above the manufacturer's predicted performance."

This 'round the clock—seven days a week operation year in and year out with high economy proves the rugged stamina and ability of the RotoGrate . . . shows why it has long been first choice among operators and top management alike.

Built to serve steam generators up to approximately 400,000 pounds steam per hour capacity, the RotoGrate is one in a complete line of Detroit Stokers . . . overthrow spreader and underfeed types for commercial, industrial and utility boiler plants—also for incineration of both municipal and industrial wastes.

**DETROIT STOKERS COST LESS** Cost equals initial investment plus upkeep, plus production losses due to equipment outage. *The total is less with Detroit.* Ask for Bulletin.

DETROIT SINCE 1898 STOKERS

**DETROIT STOKER COMPANY**
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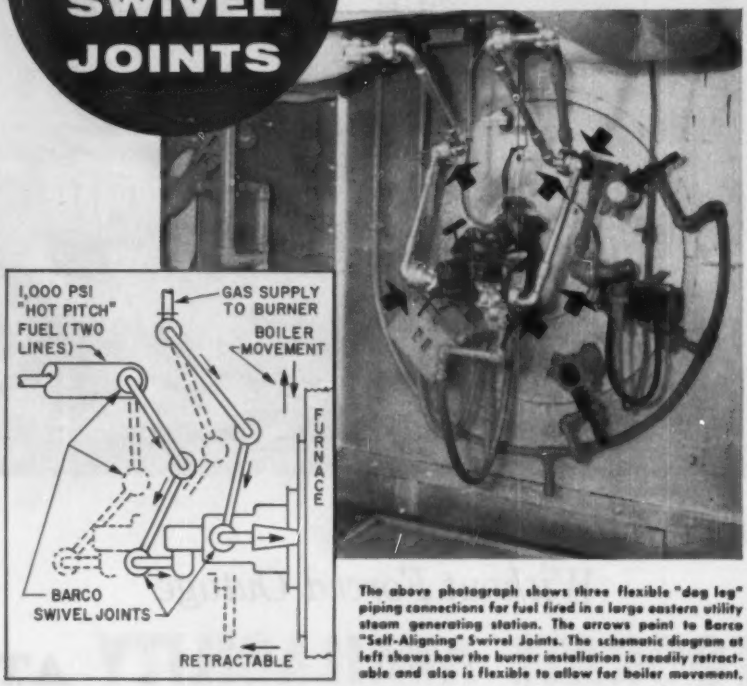
District Offices or Representatives in Principal Cities


For more facts circle 267 on Reader Service card, p 133

-Installs
BARCO
*Self-Aligning*
SWIVEL
JOINTS

# SAFETY for Burners

handling 450° Fuel at 1,000 psi




The above photograph shows three flexible "dog leg" piping connections for fuel fired in a large eastern utility steam generating station. The arrows point to Barco "Self-Aligning" Swivel Joints. The schematic diagram at left shows how the burner installation is readily retractable and also is flexible to allow for boiler movement.

## Power Plant Uses Steel Pipe for "Flexible Connections"

THE idea of using steel pipe, instead of hose, appeals to many engineers—especially where fuel is being handled at high temperature and pressure.

In the boiler plant shown above, heavy pitch, obtained from a nearby oil refinery, is pre-heated to 450°—500°F and pumped at 1,000 psi to the burners of the steam generators. On each burner, two 1″ lines feed hot pitch; a third 1½″ line (painted gray) handles natural gas for auxiliary firing.

Each line is fitted with three Barco Type S All-Steel Swivel Joints with welded connections. Periodically, all lines are purged with 150 psi steam.

*With a total of 642 Barco joints installed, only one joint has required any maintenance in two years of service.* One of the big advantages of these joints is that they have NO BALL BEARINGS. They don't bake dry at high temperatures. NO LUBRICATION REQUIRED. Another big advantage is that they are *self-aligning;* this eliminates binding and simplifies and speeds up pipe fitting. For detailed information, ASK FOR CATALOG 265D.

PRODUCTS BACKED BY EXPERIENCE
BARCO
FOUNDED 1915

**BARCO MANUFACTURING CO.**
522D Hough Street, Barrington, Illinois
*The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Rotary Joints*
In Canada: The Holden Co., Ltd., Montreal


## Free literature

Begins on page 133A

alog 101. Specs, prices are included. Research Instruments, Inc

**138** **Recorders, control stations** and transmitters for measuring differential pressures from 0-20 to 0-400 in. $H_2O$ are featured in bulletins FS-301-8 and FS301-7. Minneapolis-Honeywell Regulator Company, Industrial Div

**139** **Leak testing of tanks,** piping are topics of 6-p bulletin GET-2936. Detailed instructions on use of halogen detectors for finding leaks in enclosures that can be pressurized are given. General Electric Company

**140** **Air meters** are topic of 4-p folder 170. Hastings-Raydist, Inc

**141** **Oscillator,** pneumatically actuated and adjustable from 0.3 to 60 cpm is described in 2-p catalog P-20. Associated Control Equipment, Inc

**142** **Electronic computing systems** are topic of bulletin RPC-4000. Royal McBee Corporation, Data Processing Div

**143** **Equipment procedures** used in study of plastic deformation in metals and alloys and radiation damage in metals are illustrated in 6-p reprint. Covers scientific investigations at Franklin Institute. Philips Electronic Instruments

**144** **Guarded de null detector** is topic of 2-p data sheet ED7 (2). Schematic diagram describes operation. Leeds & Northrup Co

**145** **Digital components** and systems are featured in 8-p folder describing firm's background and facilities. Technitrol Engineering Co

**146** **Analysis services,** laboratory facilities are described in well-illustrated booklet. Spectograph, autrometer, quantometer are some instruments covered. Spectrochemical Laboratories, Inc

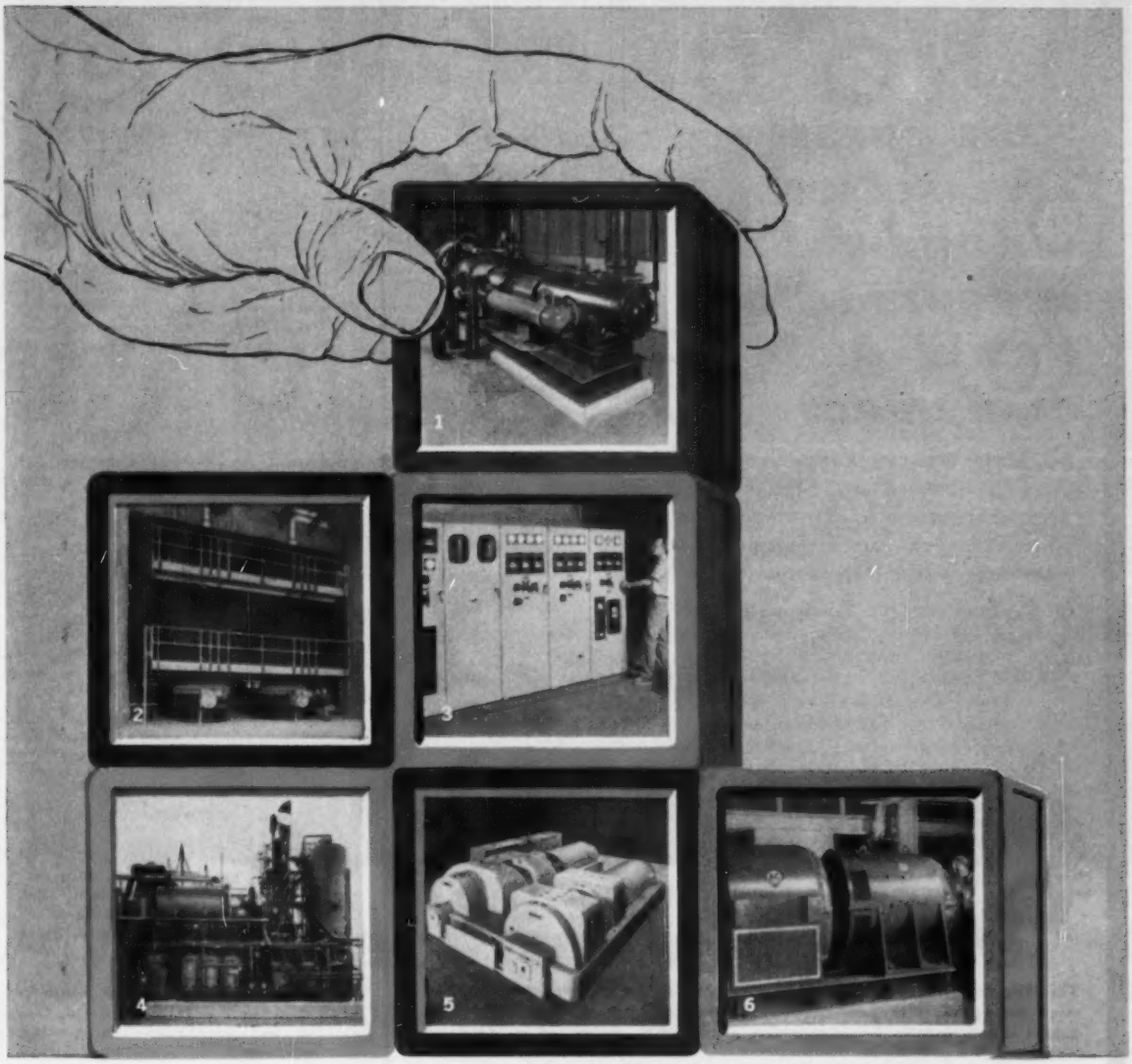
**147** **Mercury-switch-equipped** controls for differential pressure, single-stage temperature, 2-stage temperature, liquid level and mechanical movement are featured in 52-p informative 1960 catalog of firm's line. Description, specs, engineering data accompanies each control. Mercoid Corporation

**148** **Wall chart** shows ten basic X-ray techniques used in industrial quality control and scientific research. Philips Electronic Instruments

continued

# ALLIS-CHALMERS

A-1271



1. compressors, 2. condensers, 3. switchgear, 4. water conditioning, 5. steam turbines, 6. motor-generator sets.

# Plan better, build better

## with this single-source power equipment coordination

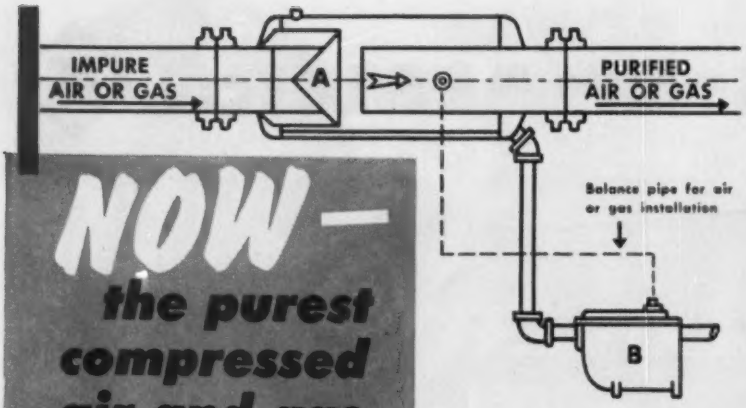
Allis-Chalmers range is wide — individual electrical products to complete power systems. And one A-C representative acts *in your interest*. He's the power product coordinator helping you plan and build better.

*His obligations to you* extend beyond products! He saves you time and money through single source buying. He coordinates engineering, products, delivery and service.

Briefly — he's Allis-Chalmers unit responsibility in *action. You'll find him at your nearby A-C office—backed in depth by Allis-Chalmers comprehensive Power Equipment Division.* **Allis-Chalmers,** *Milwaukee 1, Wisconsin.*



For more facts circle 269 on Reader Service card, p 133

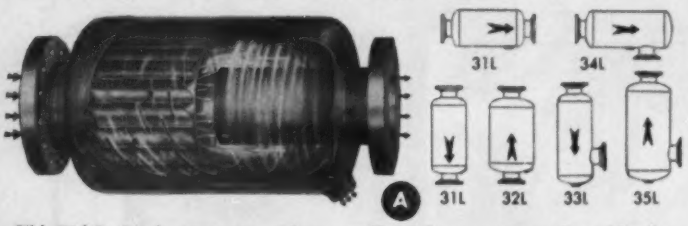



# NOW— the purest compressed air and gas is yours with this W-A equipment

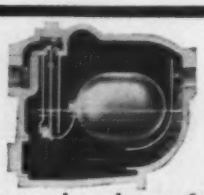
**GUARANTEED TO REMOVE 99% OR MORE OF ENTRAINED MOISTURE AND SOLIDS**

Where pipe lines carry compressed air and gas, liquids and solids are generally entrained in the gas stream. Wright-Austin 30L Series Separators can be used to remove foreign matter on a wide range of applications. For operating pressures to 5000PSIG. Line sizes to 24". Here are some typical applications:

REMOVE
- —oil and water from compressed air supply lines
- —oil and water on compressed air service at outlet of inter-cooler and after-cooler equipment.
- —oil, moisture and tar between stages in coke oven gas compressors
- —oil and water from $CO_2$ gas lines
- —oil and water from hydro-carbon lines
- —entrainment from vapor lines following evaporation




This Wright-Austin separator employs centrifugal force to remove impurities from steam, air or gas flow. The pressure drop is extremely low. Type 31N, as well as other models shown, is light weight, compact and sturdily constructed according to ASME code.



**23-AC TRAP** (0-125 PSIG)

Separated condensate flows to trap. Drainage is automatic. Particularly adapted where cold, gummy, emulsified cylinder lubricants make ordinary traps inoperative.

B

**101-AC TRAP** (0-600 PSIG)

Cast steel body, cover and bonnet. Designed for draining condensate where high pressures are involved. Internal mechanism all attached to cover for easy service.

WRIGHT-AUSTIN COMPANY
3245 WIGHT STREET • DETROIT 7, MICH.

**WRITE FOR NEW CIRCULAR 809-A**


## Free literature

Begins on page 133A

**149** **Gamma spectrometer system** is described in data folder GSS-1. Nuclear Measurements Corp

**150** **Rotameter selector aid** 110 shows firm's full line of units. Brooks Rotameter Company

**151** **Recording dc microammeter** is featured in 2-p bulletin 41. The Esterline-Angus Company

**152** **Hydraulic system** for remote-motion control or duplication is described in remote-control catalog. Hydronic Corporation

**153** **Rotameters and flow indicators** are featured in condensed bulletin M-1. Instruments for measuring, indicating, recording and controlling are pictured and briefly described. Koerting Company, Instrument Div

**154** **Bin-level - control switches** are topic of bulletin 159. Engineering data, diagrams and illustrations are included. Stephens-Adamson Mfg Company

**155** **Welding-pad gages** which can be welded onto a tank, vessel or other liquid - containing structure are detailed in 2-p data sheet 362. Jerguson Gage & Valve Co

**156** **Linear and rotary actuators** are featured in 16-p bulletin J-105 which covers 20 sizes delivering torques from a few in.-oz to 3500 in.-lb. Jordan Controls, Inc

### WELDING

**157** **Gas welding** and cutting hand torches are featured in 36-p catalog of firm's complete line. Spec charts give welding-selection tips. Air Reduction Sales Company

**158** **Stress-relieving welded joints** is topic of 3-p folder DM-117. Use of 400-cycle induction heating equipment is featured. Hobart Brothers Company

### MECHANICAL POWER TRANSMISSION

**159** **Pulleys, rollers,** bearings, bushings and guides are covered in data sheets. Lignum-Vitae Products Corporation

**160** **Ball bearings** with in. and metric dimensions are described in 4-p bulletin 112. Hoover Ball and Bearing Company

**161** **Standard transmissions** with input torque capacities of 150 to 2500 ft-lb are detailed in 8-p catalog. Cotta Transmission Co

**162** **Synchronous motors** for heavy duty, rated 60 hp and up at speeds from 500 to 1800 rpm, and

# ALLIS-CHALMERS

# No space problem here!

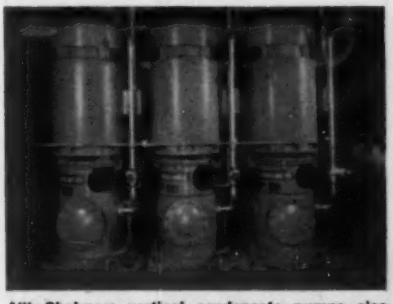
## Another utility installs an Allis-Chalmers surface condenser

**Illinois Power Company** installed an Allis-Chalmers 125,000-sq-ft, two-pass, divided water box surface condenser at its Hennepin Station (Unit 2). Improved design resulted in space saving and reduced installation costs.

A-C special cars carried unit in just three shell sections to simplify shipping, speed on-site handling and minimize erection. Extra-compact rectangular condenser shape reduced space requirements. And Allis-Chalmers unique reverse flow design for cooling water effectively back-washes debris, ends costly shutdown, conserves space, requires no additional piping.

*For details on compact A-C condensers from 100 to 200,000 sq ft and larger, call your nearby A-C office or write* **Allis-Chalmers,** *Power Equipment Division, Milwaukee 1, Wisconsin.*

**Allis-Chalmers circulating pumps** with vaned elbows allow use of smaller inlet tunnels and permit adjacent pumps to be located closer together. Result, considerable saving in overall space requirements.



**Allis-Chalmers vertical condensate pumps** also save space. With the first stage impeller located below floor level, the required NPSH can be gained in the pump tank. This feature permits a shallower basement.

A-1274



For more facts circle 271 on Reader Service card, p 133

Wiley BOOKS

# DIRECT CONVERSION OF HEAT TO ELECTRICITY

*Edited by* JOSEPH KAYE *and* JOHN A. WELSH, *both of M.I.T.* Covers the thermodynamics of irreversible processes and extends it to thermoelectricity, thermionic emission, and direct conversion of heat to electricity. Gives research reports including investigations of the thermoelectron engine and solid-state thermoelectric generators. Industrial development of such devices is described by members of firms active in the energy-conversion field. *1960. Approx. 384 pages. Prob. $8.75*

# FLUID POWER CONTROL

*Edited by* JOHN F. BLACKBURN, *Raytheon Co.,* GERHARD REETHOF, *Vickers, Inc., and* J. L. SHEARER, *M.I.T.* Based on research and development in many challenging systems fields. It covers the fundamentals, various devices, dynamic analysis of fluid systems, electronic analogues, and pneumatic servomechanisms—and includes dynamic response characteristics of components, stressing load effects. *1960. 710 pages. $17.50*

TRIAL ORDER P 30

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circle 272 on Reader Service card, p 133

## Free literature

Begins on page 133A

variable-speed vertical magnetic drives are shown and described in spec sheets. Electric Machinery Mfg Co

### MAINTENANCE

**163** **Blast-cleaning machine** for miscellaneous work, the rotoblast table, is introduced in 12-p bulletin 805. Photos, cutaways, dimensions and specs of eight table rooms are given. Pangborn Corporation

**164** **Identification system** for maintenance and safety is explained in 32-p catalog. Price list and free testing samples are included. W H Brady Co

**165** **Ten maintenance steps** for engine care are featured in new bulletin. Cummins Engine Company, Inc

### PUMPS

**166** **Centrifugal pumps** are topic of folder 670E. Specs are included. Fostoria Corp, Dynapump Div

**167** **Slurry pump** with variable-flow volume from 0 to 180 gph at pressures to 90 psi is detailed in 4-p bulletin 1158. Milton Roy Company

**168** **Displacement pump** with 15-220 gpm rating, discharge pressure of 100 psi is subject of info sheets. Performance curves, dimensions and descriptions are given. Goodyear Pumps Inc

**169** **Seal-less canned pumps** for h-t hot-water heating systems are discussed in 4-p bulletin 5. Fostoria Corp, Chempump Div

### SAFETY EQUIPMENT

**170** **Fireproofing system** for ceilings, beams, girders and columns is described in 4-p brochure. Gives installation drawings, test data and ratings, specs. Columbia Acoustics and Fireproofing Co

**171** **Safety handbook** for industrial plants covers gratings, stair treads, safety edgings. Handbook 60 has 24 pp. Bustin Steel Products Co

### VALVES, PIPING, FITTINGS AND SPECIALTIES

**172** **Hydro valve line** is detailed with specs on sizes, capacities, materials in 4-p bulletin L-100/59. J E Lonergan Company

**173** **Welding fittings** and forged-steel flanges are cataloged by size, dimensional and physical data

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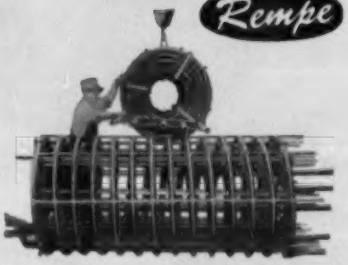

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Coil illustrated is a Custom Engineered multiple spiral assembly fabricated from 1½" IPS extra heavy Inconel. Similar units can be fabricated for any application from Stainless Steel, Nickel, Copper, Aluminum or any other workable material required for the job.

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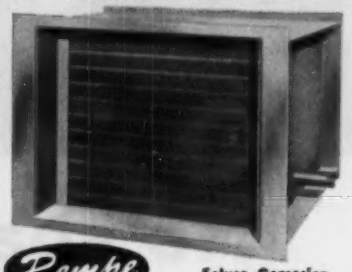

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# ALLIS-CHALMERS

A-1244

Microscopic view of common algae found in cooling systems.

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**Lethal to more algae than any other algaecide!** Only 2 to 5 ppm of this amazingly effective liquid does the job . . . proves the ideal solution to problems of plugged pump strainers, fouled heat exchanger tubes and coated cooling tower slats.

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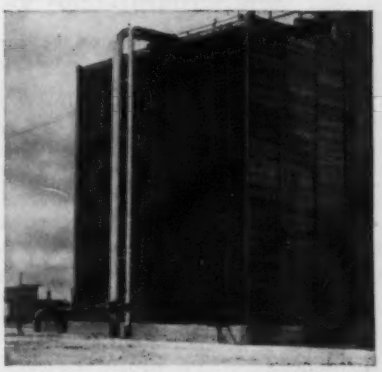


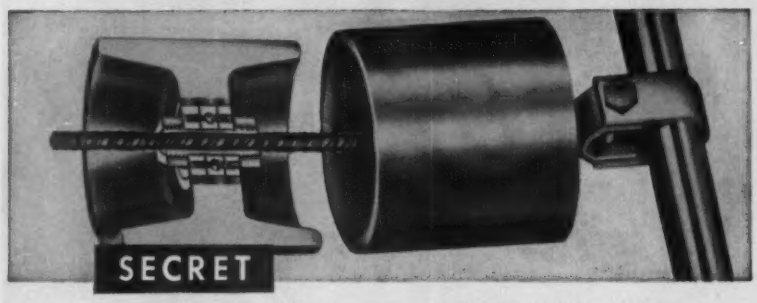
Scale and corrosion problems in cooling systems are covered in Allis-Chalmers Informational Bulletin No. 74-A, "Water Treatment for Cooling Towers." Write for your copy today.



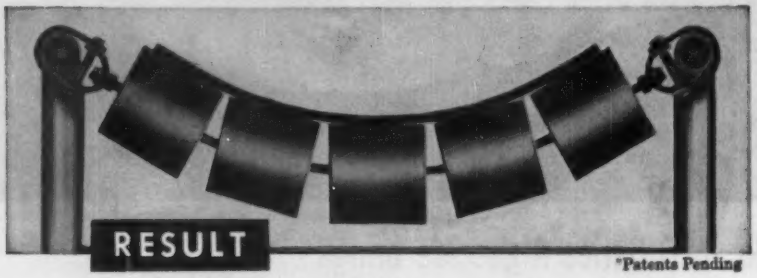
For more facts circle 274 on Reader Service card, p 133

# NEW (EXCLUSIVE WITH McNALLY PITTSBURG) CONVEYOR DESIGN

## ... slashes maintenance cost!
## ... extends belt life!




... of the amazingly improved efficiency of this modern belt conveyor is shown here. This new McNally Pittsburg Cradle Idler* consists of 5" rubber rollers assembled on precision ground ball bearings, prelubricated and lifetime sealed. Being a *true catenary* suspension with rollers mounted on flexible, *non-rotating* stainless steel wire rope, this design eliminates "loping" and dangerous harmonics.




*Patents Pending

... is greater capacity and faster belt operation with minimum spillage. Since the belt lies in true arc with no creases or bends to cause wear, *belt life is substantially increased.* Because this McNally Pittsburg conveyor design is so simple, costs are lower, and erection time is reduced.

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## Free literature

Begins on page 133A

in bulletins FDC 252 through 275. The Babcock & Wilcox Company, Tubular Products Div

**174** **Clad tube sheet** in diameters from 26 to 42 in. is described with technical data in spec sheets. Bridgeport Brass Company

**175** **Mechanical-seal nomograms** should facilitate determination of frictional heat and power absorption for rotating mechanical seals. Sealol Corp

**176** **Hose, fittings,** self-sealing couplings are covered in 38-p industrial catalog 204. Well-illustrated catalog has complete specs. Aeroquip Corp

**177** **Packings made of fabric,** foil, plastic or filament are detailed in 8-p bulletin. Fourteen different types, nine constructions are described and illustrated. Greene, Tweed & Company

### WATER TREATMENT

**178** **Deionization processes** and equipment are discussed in 4-p bulletin. Discussion of applications is included. Illinois Water Treatment Company

**179** **Evolution of condensate drainage** is topic of 4-p reprint 126. Cochrane Corporation

**180** **Fiberglass tanks** for water-softener applications are described in new bulletin. All tank models and specs are listed. Apex Reinforced Plastics

**181** **How corrosion attacks** industrial water systems is discussed in water-conditioning data sheet. Betz Laboratories, Inc

**182** **Research problems** relating to production and quality control of ultrapure feedwater for Eddystone Station are covered in reprint. Analytical methods for measuring condensate quality are discussed. Graver Water Conditioning Co

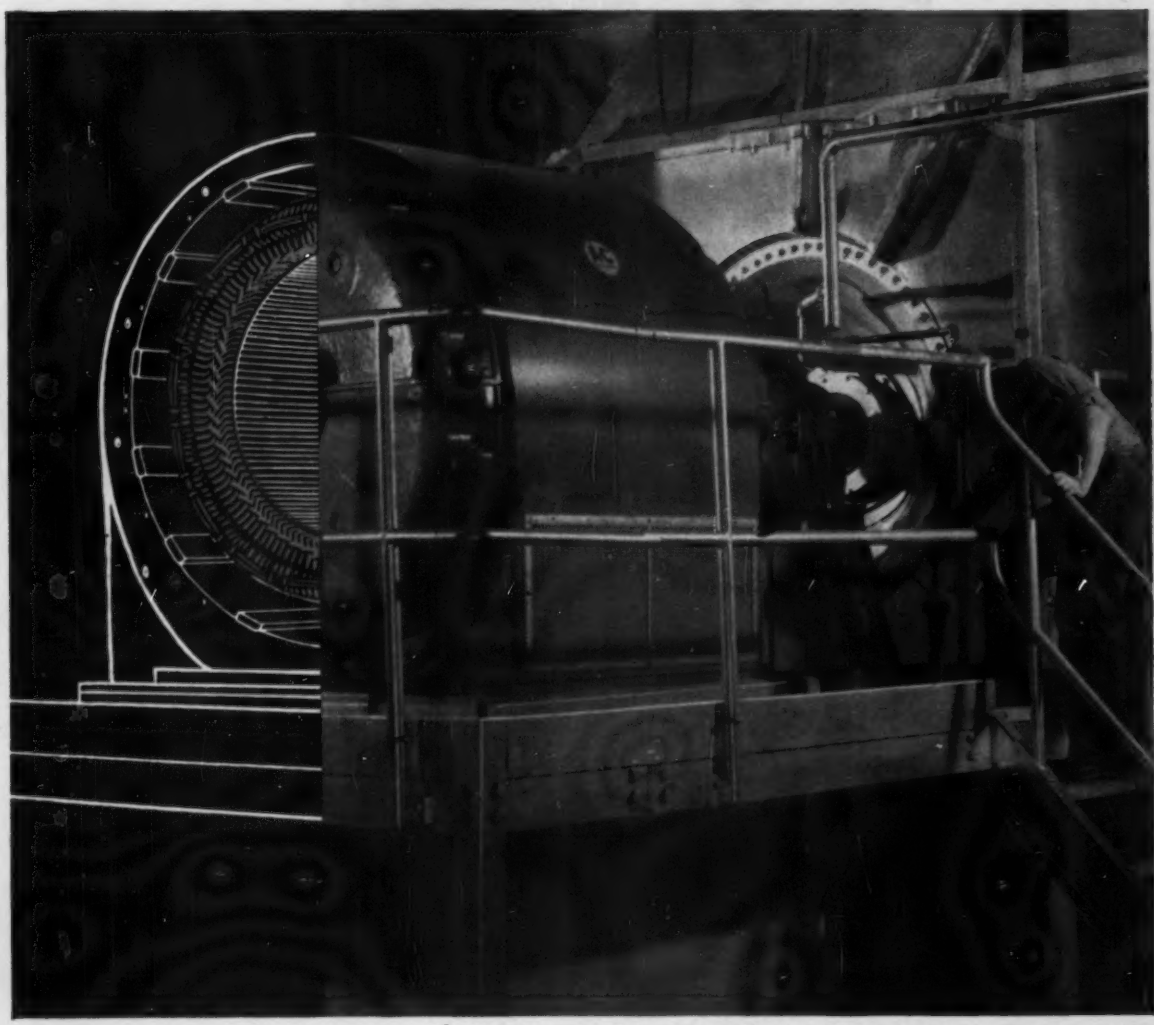
**183** **Chemical control** for feeding balanced chemical treatment into circulating-water systems of cooling towers and evaporative condensers is introduced in folder. Erlen Products Co

**184** **Hydraulic dredging** for solving utility silting and channeling problems is subject of illustrated report. Ellicott Machine Corp

### MISCELLANEOUS

**185** **Firm's catalog** lists 1000 official U.S. Government specs covering adhesives, paints, cleaning and chemical compounds. Magic Chemical Company

# ALLIS-CHALMERS



**Silco-Flex** insulation in this induced draft fan application has solved the problems of heat and abrasive action of fly ash and coal dust encountered in power plants.

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**FARROWTEST REJECT TABLE**

| Wall Thickness (B.W. Gage) | Minor dimension of the defect (Length or Depth) | Defective Area (Length, Depth Plane) |
|---|---|---|
| 20 | .006" | .0025 sq. inches |
| 18 | .006" | .003 sq. inches |
| 16 | 12½% of wall | .003 sq. inches |
| 14 and 13 | 12½% of wall | .004 sq. inches |
| 12 and heavier | 12½% of wall | .005 sq. inches |

FARROWTEST detects and rejects not only tubing containing defects which completely penetrate the wall; but also tubing with defects equal to, or greater than, those shown in this table. For irregular defect shapes, a tube with defect area equal to or greater than shown above is rejectable. Where required, sensitivity of FARROWTEST equipment can be calibrated to reject defects of lesser specified area than shown in table, at extra cost.

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Full normalizing, uniform wall thickness and diameter, and true concentricity, assure easy workability and in service dependability. Bends are smooth and uniform. Rolling-in operations are easier. Results: Greater savings in installation time and costs.

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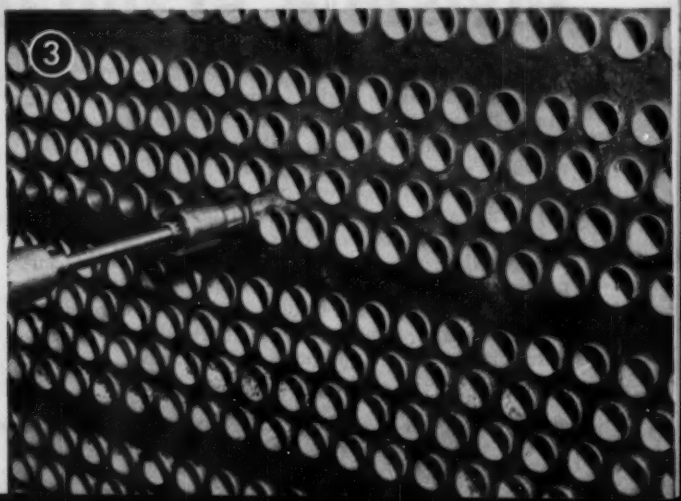
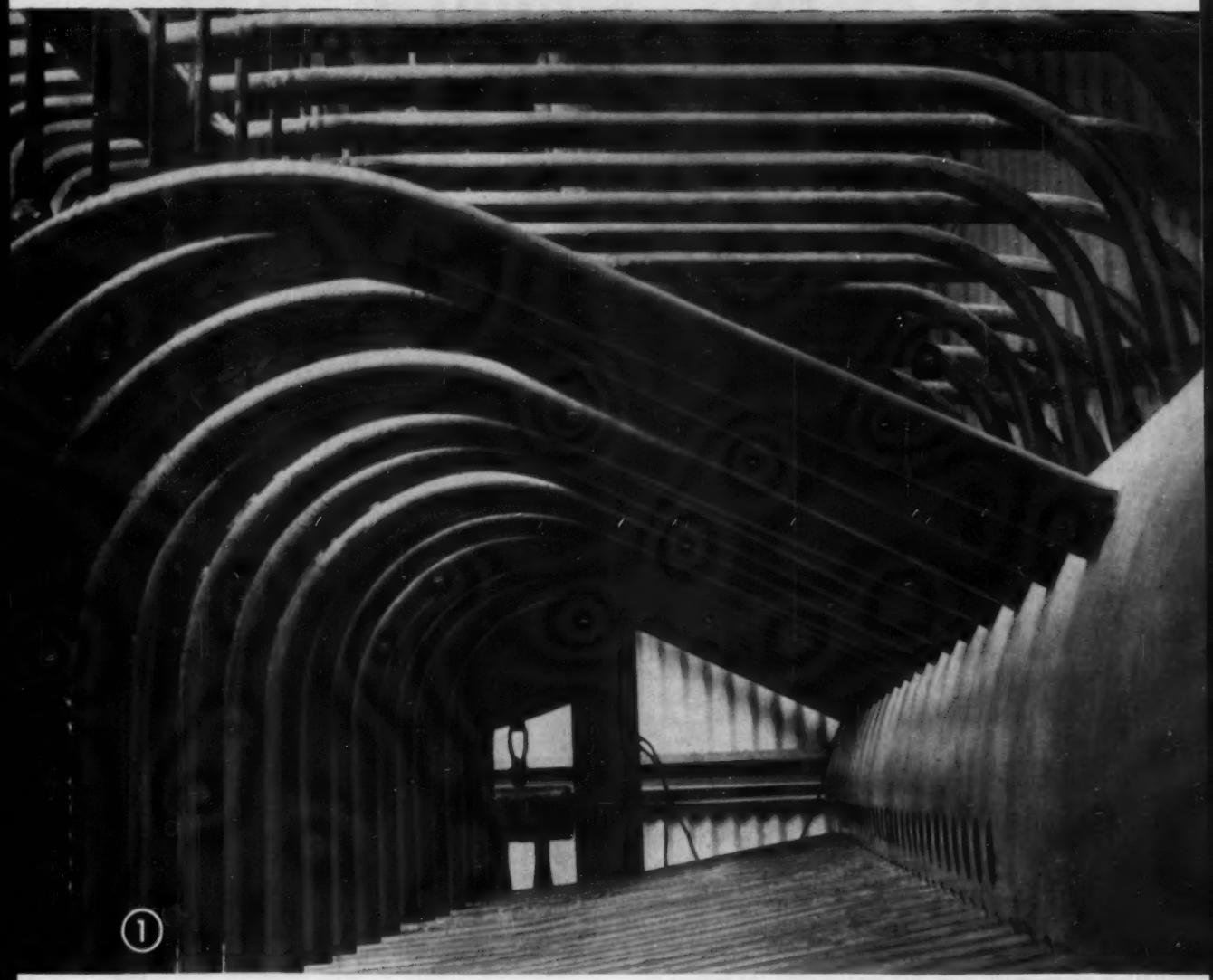
To learn more about ELECTRUNITE for boiler, heat exchanger, condenser, or evaporator applications, call your Republic representative, or write direct.



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REPUBLIC STEEL

# REPUBLIC STEEL

**STEEL AND TUBES DIVISION**

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# Expansion Joint Design Moves out of the "Model T" Era

**Badger first began fabricating packless metal bellows expansion joints more than 35 years ago. These "Model T" joints performed (and are still performing) with outstanding success in hundreds of process and steam line piping installations.**

**Starting in the 30's other expansion joint manufacturers entered the field. The most successful adopted many of the basic features of the original Badger design.**

**During the last decade, as industry's requirements became more stringent, and joint manufacturers gained fabricating and field experience, certain fundamental problems inherent in the early designs became evident. Most of these problems were solved through a series of modifications. (Among which was the Badger Directed Flexing Self-Equalizing Joint — the famous "DFSE" Design.) But, at best, the modifications were stop-gap measures which complicated the joints and greatly increased their weight. A fundamental reassessment of expansion joint engineering data was needed. Badger led the way: In 1956, a task force completed a three-year research program and the first S-R (Service-Rated) Expansion Joints were produced.**

**In the three years they have been available, S-R Expansion Joints have been both an engineering and a sales success. But like many revolutionary concepts which upset tradition, the full implication of the advantages S-R Joints offer is still not universally understood. The message that follows is an attempt "to set the record straight."**

• • • • •

## Equalization — fact and fiction

Many users of expansion joints are under the impression that the so-called "equalizing" rings on today's conventional type expansion joints distribute movement equally among all the corrugations of the bellows. It is argued that as the joint absorbs thermal movement, the tops of the rings progressively come into contact until the bellows is fully compressed thus limiting the amount of compression which any one corrugation can ultimately absorb (see diagram 1). In *this* sense the rings do contribute to the "equalization" of movement by physically limiting the compression of each corrugation to the distance between any two adjacent rings.

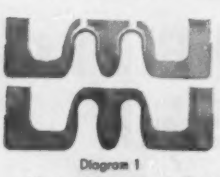

Diagram 1

**Conventional Type Expansion Joint.** Cross-sections of rings and bellows of a conventional "self-equalizing" joint showing cold and hot positions. Note that true equalization of movement can only be obtained when tops of all rings are in contact — an impractical and dangerous situation.

Note, however, that the degree of compression will not be truly equalized until the tops of all the rings are in contact. But, when such a condition occurs, serious problems will result. If the limit of compressibility is reached before the thermal expansion has been completely absorbed, exceedingly large forces will be transmitted through the pipe line to the anchors and connected equipment. On the other hand, if the joint is compressed only partially, not all of the corrugations will absorb movement to the same degree.

## How S-R Joints solve equalization problem

Badger S-R Expansion Joints feature the new Curvilinear Corrugations which naturally assume an "all curve" shape under pressure (diagram 2), assuring more equal distribution of stresses throughout the bellows material. Furthermore, the shape, height and pitch of the corrugations are based on a carefully engineered correlation. Thus, reasonably equal distribution of movement among the corrugations is obtained, even in joints not equipped with reinforcing rings.

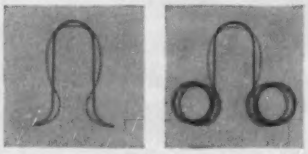

Diagram 2

**Badger S-R Expansion Joint.** Cross-sections of S-R Joints (Series 50 left, Series 150 right). The movement of the corrugations is shown by dotted and solid lines. Compare configuration and effective height of corrugations, position and size of rings with conventional joint.

Equalization of movement is inherent in the design and functioning of the bellows on Badger S-R Joints. On the basis of provable engineering criteria, the prime purpose of reinforcing rings of any design is to retain the hoop dimension (diameter) of the corrugations when they are subject to internal pressure. This Badger's simple, lightweight tubular reinforcing rings do. But, in addition, the new tubular shape of the rings does contribute to joint flexibility and life by permitting flexing over a more effective portion of the total corrugation height than conventional cast or fabricated equalizing rings.

## Better performance, lower cost

Briefly, then, Badger S-R Joints alone offer these advantages: Better equalization of movement which results in elimination of localized stresses and leads to longer joint life; a simple, lightweight design that makes installation easier, eliminates cumbersome castings and fragile mechanical devices; complete range of sizes from 3" to 72" made from any workable metal and with a wide choice of accessories.

Badger S-R Joints are probably the answer to your problem. There's an easy and quick way to find out — ask the Badgerman for his recommendations. Write or phone today. Badger Manufacturing Co., 230 Bent St., Cambridge, Mass.

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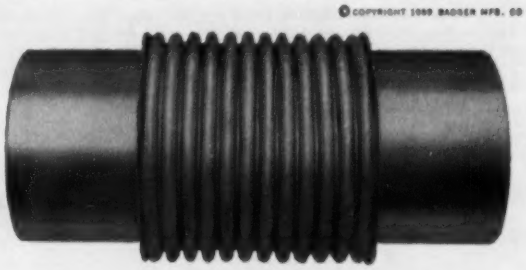
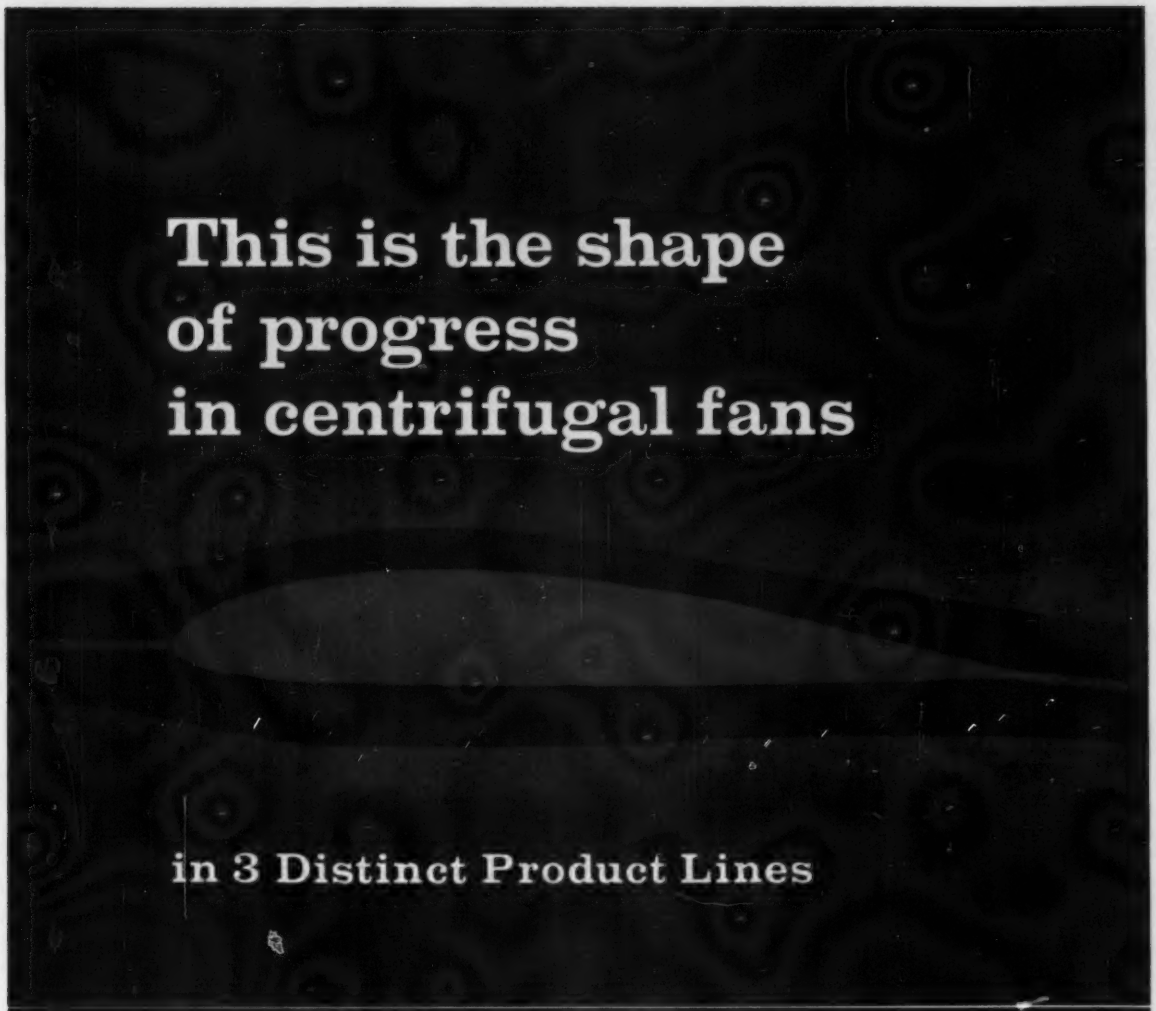


**BADGER S·R EXPANSION JOINTS**

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|---|---|---|---|
| **Volumes (cfm)** | 10,000 to 700,000 | 25,000 to 350,000 | 6,000 to 50,000 |
| **Pressures ("$H_2O$)** | Up to 45" | 45" to 90" | Up to 65" |

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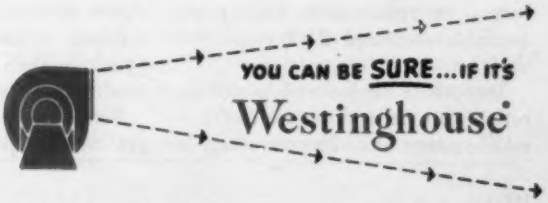
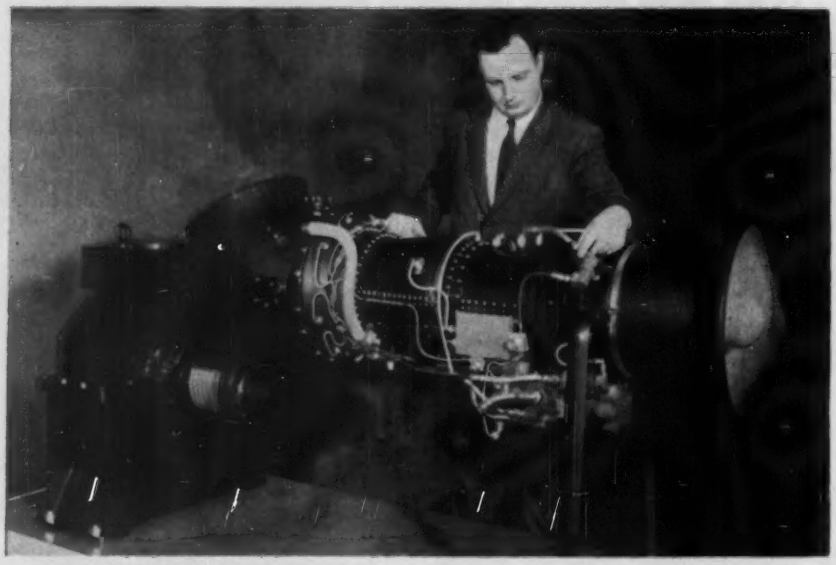


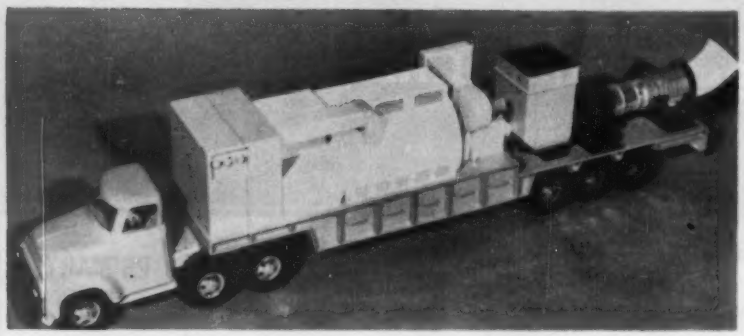



For more facts circle 279 on Reader Service card, p 133

For more data on these developments, circle key numbers on Reader Service card, p 133

# Plant equipment news... Your





**WEIGHT** of turbine engine, above, is 300 lb excluding reduction gearing (800 to 900 lb). Simply detach gearing for servicing

**MODEL** of 7500-kva mobile power unit shows lightweight gas generator in rear

## Compact gas turbines meet need for mobility

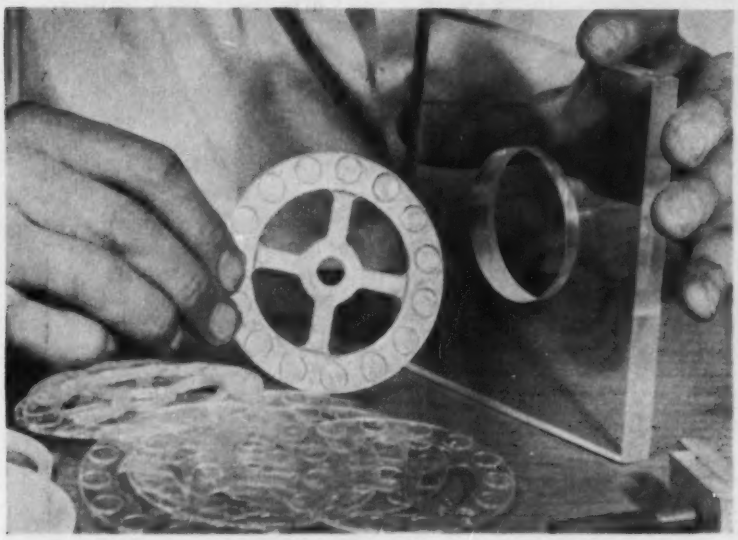
1 • Line of ultra-lightweight gas turbines with high power-to-weight ratios and compact size is especially designed for applications where mobility and small size are requirements. Line will range in output from 50 to 20,000 shaft hp, serve as prime movers in electrical-generating operations, drive power-supply systems for production of electricity in remote locations and handle auxiliary or emergency uses. Two models available are rated 20,000 and 900 shaft hp.

Turboshaft engine with 20,000-hp rating can be applied to 7500-kva mobile power unit. Its compressor is 17-stage axial-flow single-rotor-construction type. First six stator stages and inlet guide vanes are variable to provide rapid stall-free starting. The 3-stage turbine has wheels coupled to compressor rotor by conical shaft for low weight and high strength. Lightweight turbine casing consists of fabricated sheet metal. Controls are hydromechanical with power required for operation supplied by engine. Power turbine is self-contained unit attached to back of gas generator. Speed is controlled through speed-sensing alternator.

Maximum continuous 900-shaft-hp gas turbine operates on liquid fuels such as kerosene, marine diesel fuels. Sister model will run on natural gas. With running accessories weighing 300 lb, fuel consumption at maximum continuous power is 11,500 Btu per hphr.

In operation, air enters screened bell mouth inlet, 10-stage compressor pressurizes it. Air then flows into annular combustor, mixes with fuel and ignites. Resulting expanding gases flow through 2-stage gas-generator turbine which drives compressor, then pass through single-stage free power turbine whose shaft is power-output source to reduction gear. Light weight and small size permit easy handling—two men can carry basic engine which weighs only 300 lb.—General Electric Co

# information center for new products and materials



## Underdrain's false bottom minimizes space

2 • New underdrain system for filters, softeners and ion exchangers consists of plastic-disk type strainers attached to false bottom. False bottom will not increase rinse requirements because of water between false and true bottom, says maker. False bottom has greater radius and minimizes space between two bottoms. Disk type strainers fastened directly to false bottom eliminate need for gravel, anthracite or other inert subfills.

Some advantages of the setup: strainers and fastenings are nonmetallic, design is adaptable for demineralizing units.—Permutit Company

## Combination filter for air, hydraulic fluid

3 • Coarse-wire screen for large particles and cellulose sheet sandwich a specially developed nonwoven material for stopping large quantities of small particles in 3-stage full-flow filter. Capable of 1-micron filtration, 2- to 10-gpm elements have filtered 20 grams of fine dust at pressure drop of 4 psi, 60 grams at 60 psi. Combination filter medium having both hydraulic and pneumatic applications works as mist remover in air cooling and prefilter for hydraulic fluids.—Purolator Products, Inc.

## Steam trap offers bellows within a bellows

4 • Double-bellows construction of themostatic-modulating steam trap balances closing force of valve being held into the seat. Forced balance allows outer bellows to move only in relation to steam in the trap. Without steam, bellows moves valve off seat to any point necessary to modulate incoming condensate. According to maker, life of bellows is infinite because of balanced, modulating trap which does not cycle.

Lightweight trap has same orifice for all pressures up to 150 psi, requires no special supports, platforms or piping.—The C E Squires Co

## Boiler return system saves fuel, steam

5 • System is said to maintain positive differential between steam supply and return lines. Hence, condensate and air are quickly evacuated from steam line, permitting processing units to operate continually at full capacity, according to manufacturer. Steam requirements are reduced because condensate is returned to boiler usually within 10 deg of saturated-steam temperature. System consists of receiver tank for condensate, two 2-stage pumps, differential valve, piping, remote control panel. Boiler range is 3500 to 70,000 lb per hr.—Stickle Steam Specialties Co

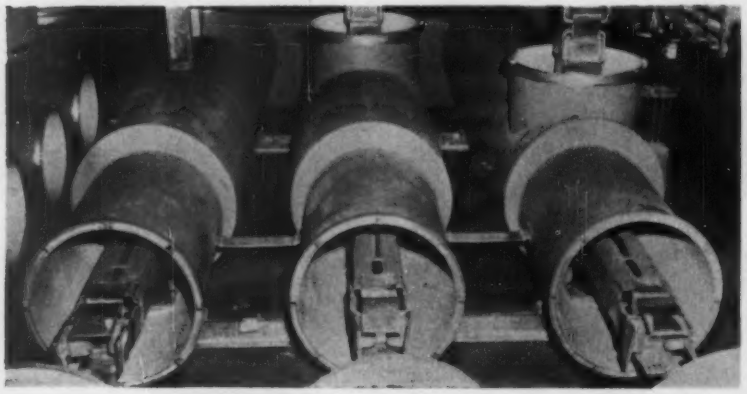
## Gas, light-oil boiler handles hot water, steam

6 • Unit is designed to handle gas, light oil or gas and light-oil combinations, offers firing and controls tailor-made for most heating and process loads in 800 through 3500 lb per hr range, according to maker. Efficient fuel economy is in part obtained from fiber-glass insulation for cutting heat losses and front-head air cushion for providing cool, clean combustion air of predictable density and volume. Four passes maintain high gas velocity, assuring heat transfer between hot gases and boiler water. Hot water, steam units are available.—Cleaver Brooks Company

For more data on these developments, circle key numbers on Reader Service card, p 133

# More **equipment news**

For more data on these developments, circle key numbers on Reader Service card, p 133



## Phase-bus design eliminates circulating-current losses

7 • New design concept of isolated-phase bus is said to greatly reduce occurrence of circulating currents. Designed for generator-station service, new bus duct is arranged so that longitudinal currents will circulate in conductor enclosures at all times. This circulation should minimize problems associated with induced currents occurring in structural members parallel to the plane of 3-phase bus duct. According to manufacturer, losses produced by such circulating currents are eliminated by the new design.

Bus features field-welded enclosures reducing voltage buildup between enclosures and ground. Design retains single-insulator support principle. Bus can be self-cooled, forced-air cooled or furnished for 105-degree high-temperature operation, says maker.—General Electric Company

## Carbon-arc lead burner for on-the-job repairs

8 • Burner, easily toted in a mechanic's tool box, is designed for making on-the-job repairs to industrial storage batteries and for general heating jobs. Power for the flameless electric burner can come right from the battery being repaired or even from an ordinary automotive battery. Equipped with a pencil-tip carbon heating rod to melt the lead, burner is much faster and more convenient to use for removing connectors than method of drilling out terminal posts, says maker.

Burner can also be used with chisel-point heating rods (easily interchanged by squeezing lever of a spring clamp) to weld terminal-post seal rings found on stationary batteries for switchgear operation, control and emergency power and lighting. Its concentrated heat can be applied to hard-to-reach parts for such jobs as melting a soldered electrical connection.—Electric Storage Battery Co, Exide Industrial Div

## Feeder-voltage regulators are automatic, self-contained

9 • Units are for use wherever a 3-phase load is to be regulated to a desired voltage level. Completely automatic and self-contained units, 60-cycle 3-phase step type, are rated 500 and 750 kva for 8.66- or 13.2-kv circuits. Control detects variations due to supply-voltage change or load-circuit change and necessary correction is made, says maker.

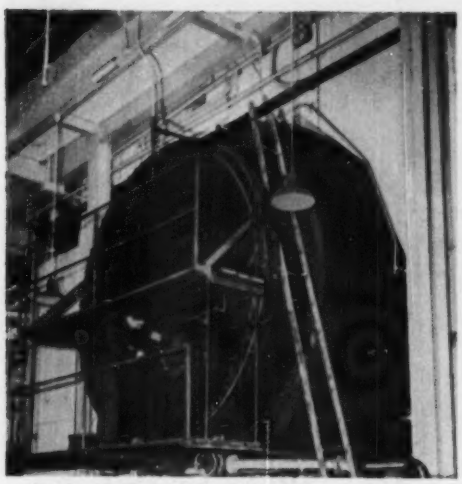
Features are 16-step voltage regulation over 20% range resulting in fewer operations and extended contact life, voltage-regulating device and time delay which monitors voltage and corrects abrupt voltage change.—Westinghouse Electric Corp

## Breaker-interrupter hybrid is rated 34.5 through 138 kv

10 • New family of switchgear for handling circuit-interrupting duties resembles load-interrupter switch but works like circuit breaker. Designed for h-v switching, unit mounts, opens and closes like a load interrupter, also works like a load interrupter to isolate circuits visibly with air. But unit carries current continuously through its interrupting element like a circuit breaker. It trips from stored energy and stores its own energy. Circuit-switcher has positive sequence control built into its mechanism. Suggested applications include transformer switching, load dropping and switching.—S&C Electric Co

For more data on these developments, circle key numbers on Reader Service card, p 133

# After 19 years...
# 99% OF ORIGINAL BRIDGEPORT TUBES STILL GOING STRONG



Condenser for main turbogenerator in which Bridgeport tubes maintain a record of high efficiency and long life.

This steam condenser tube record at a New England utility isn't often equaled. The 25,000 sq. ft. condenser in this plant contains 4,340 18-gauge Bridgeport Aluminum Brass tubes, each 22 ft. by 2 7/32 in. In 19 years of operation only five tubes have had to be replaced.

The plant serves 100,000 people, generating a total of 65,000 kw. The condenser uses harbor salt water, filtered through half-inch mesh screening with chlorine added for slime control. The harbor water has a high ammonia content.

Tubes are Aluminum Brass—77% copper, 2% aluminum and 21% zinc—a *standard* Bridgeport alloy that, in this case, is giving *exceptional* service.

Making the exception the rule is an everyday occurrence at Bridgeport. Technical Service, research, and manufacturing techniques and facilities—all are aimed at duplicating stories like this in condenser and heat exchanger operation.

A call to your nearest Bridgeport Sales Office puts this assistance at your elbow. Dept. 5402.

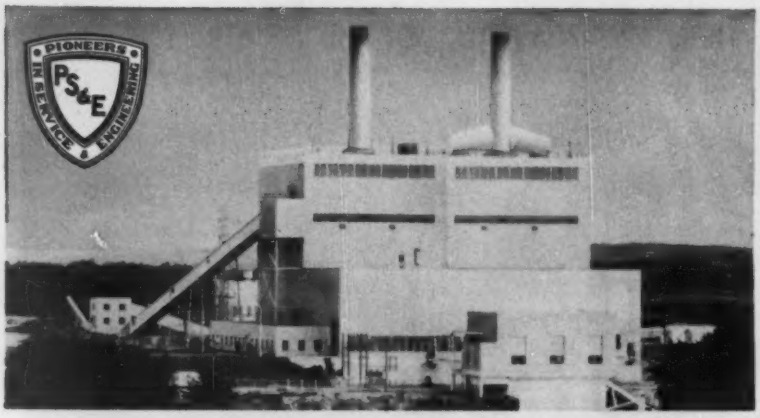
**BRIDGEPORT CONDENSER TUBES**

**Bridgeport Brass Company, Bridgeport 2, Conn. • Sales Offices in Principal Cities**

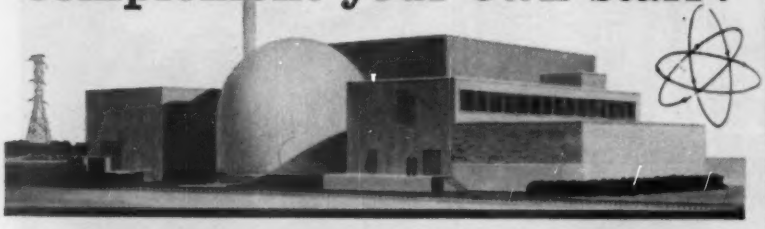
*In Canada: Noranda Copper and Brass Limited, Montreal*

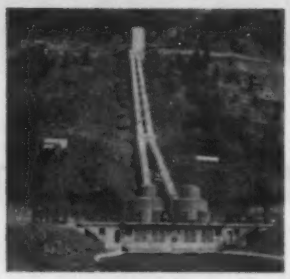


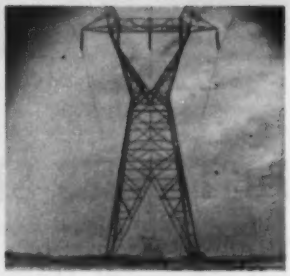
**For more facts circle 280 on Reader Service card, p 133**



# Which Pioneer service do you need to complement your own staff?







**DESIGN AND CONSULTING ENGINEERING SERVICES**

Pioneer specializes in designing power plants and offers design service for fossil fuel, hydro and atomic plants. It will also assist in forecasting load growth, in site selection, in purchasing and expediting of equipment and construction management. Pioneer's other services include substation, transmission and distribution studies and design.

**SERVICES IN REGULATORY MATTERS**

Pioneer offers its services in all phases of Federal, State and local utility regulation, including natural gas and electric rate matters, certificate proceedings, licensed project accounting requirements, depreciation studies for rate case and income tax purposes, cost allocations and special studies.

**CORPORATE SERVICES**

Pioneer offers its services as business and management consultants; stock transfer and dividend disbursing agents; financial, accounting and tax consultants.

Write for Booklet "PIONEERING NEW HORIZONS IN POWER"

*Serving Electric Utilities and Industrial Power Users Since 1902*

**Pioneer Service & Engineering Co.**

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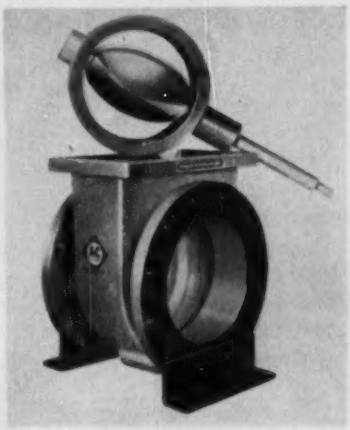
## Equipment news

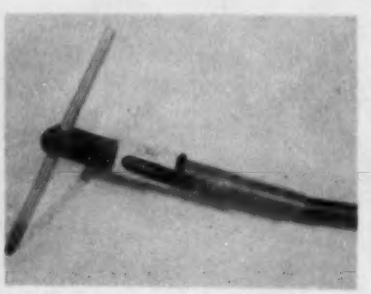
Begins on page 148



### Cartridge valve

**32** • Cartridge butterfly valve is designed for quick and easy replacement. Cartridge unit consists of a standard butterfly valve in a wedge-shaped body which is inserted in the outer body and held in place with the cover. Its flow characteristics are identical to the standard 2-flange valve. — Allis-Chalmers Manufacturing Company

Just circle key numbers on the Reader Service card, page 133, to get complete product story



### Heavy-duty torch

**16** • Manual torch uses heat of electric arc to melt metal and stream of compressed air to blow it away. It is especially used for fast removal of large areas of metal, says maker.

# ...the most unusual curtain wall

MONOPANL®

A factory-assembled wall panel in one foot modules . . . one that is self-sealing for life by mere installation. You never caulk it. And there are no visible outside joints or fasteners to mar the surface. This is Butler Monopanl, the most unusual curtain wall. Tongue-and-groove joints with double vinyl gaskets provide the seal. The cross section sketch tells the story.

Spanning ability is exceptional, as you can see from the configuration. Glass fiber insulation will not settle.

Beautiful Monopanl is furnished in a range of gauges. Exterior and interior faces can be specified in aluminum or galvanized steel. Choose from a selection of factory-applied colors. Integral fenestration is available.

For further information refer to Sweet's 1960 Architectural File. For complete technical details and actual samples of Monopanl, contact your Butler Builder He's listed in the Yellow Pages under "Buildings" or "Steel Buildings." Or write direct for a descriptive brochure and data sheets.

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For more facts circle 282 on Reader Service card, p 133

# MERCOID® CONTROLS

## NEW CATALOG AVAILABLE

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Controls for—

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- MERCURY SWITCHES
- TRANSFORMER-RELAYS

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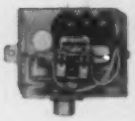


TYPE AP-153

New SP-DT low pressure (instrument air) control. Small in size, light in weight. Provides any of following operations: SP cut-in high; SP cut-in low; or SP-DT operation. Two operating ranges 1 to 20 and 1 to 30 psig. External adjustments, visible dial and visible circuit position. See catalog No. 860

TYPE PG

New low pressure diaphragm control for gases or air. Can be used three ways; for pressure, negative (vac.) pressure or differential pressure. External adjustments, visible dial and visible on-off circuit position. Two operating ranges, 1.0" to 30.0" and 1/2 to 5 psig. See catalog No. 860

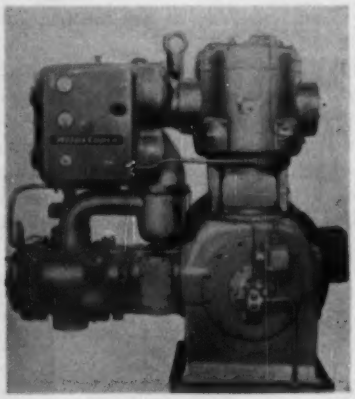
ASK FOR CATALOG NO. 860

THE MERCOID CORPORATION
4211 Belmont Ave., Chicago 41, Ill.


## Equipment news

Begins on page 148

Well-insulated unit has sleeve of silicone-glass laminate on torch handle, rubber boot for connection on end of cable.—Arcair Co



### H-p air compressor

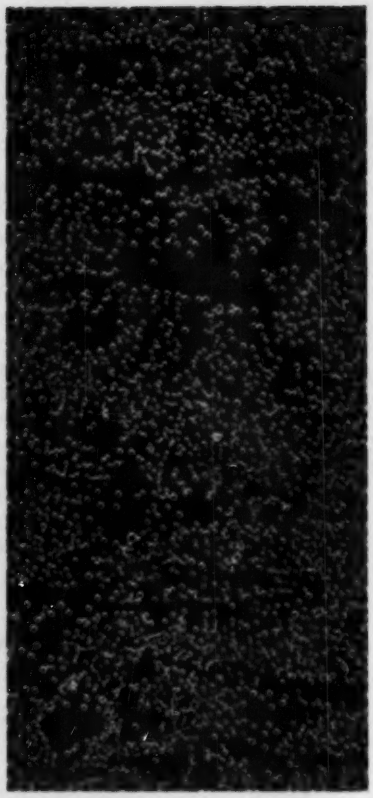
**18** • High-pressure air compressors have output ranging up to 498-cu-ft air per min at 225 psi. Units incorporate crosshead design which allows crosshead shoes to absorb large lateral stresses developing in h-p compressors. These 2-stage, water-cooled units have somewhat smaller cylinders than standard compressors. Air delivery is within a relatively low temperature range, assuring long service for the compressor valves, according to maker.—Atlas Copco

Just circle key numbers on the Reader Service card, page 133, to get complete product story

### Fluid drives

**25** • Developed for use with on-the-shaft boiler-feed-pump drive arrangements, these units are particularly designed for heavy-duty requirements. According to maker, they provide adjustable speed control which saves power over entire operating range. Standard units are available for either 3600- or 1800-rpm operating input speed.—American-Standard Industrial Div

continued

# DEOXY-SOL REDUCES OXIDES

in boiler feed water
yet
adds no solids

— and that may be a good reason to select DEOXY-SOL for treatment of your boiler water. But it provides other advantages also.

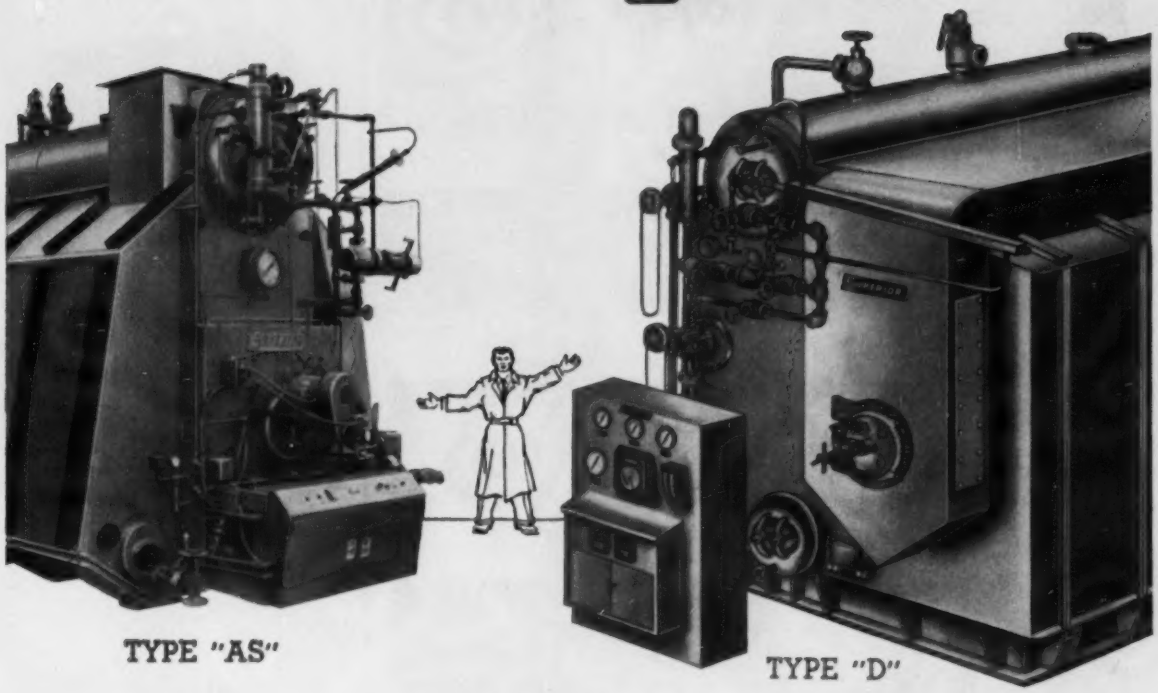
**DEOXY-SOL** is a high efficiency oxygen scavenger, since it is a solution of hydrazine. And it raises the pH, supplementing any amine treatment.

Stocks in Newark, N. J., Chicago, Ill., Los Angeles, Calif.

Write for informative Bulletin BW.

Fairmount
CHEMICAL CO., INC.

# WHEN YOU SELECT SUPERIOR...



TYPE "AS"

TYPE "D"

## You Choose...*Without Compromise*

**The Type D Superior Packaged Boiler** covers a broad capacity range from 11,000 to 61,000 lbs. of steam per hour. To the time-tested and well-known advantages of its basic design, Superior's Type D brings a number of exclusive features. Not the least of these is its rear-mounted draft fan which provides quiet operation, stable flame propogation by uniform burner register performance, air-cooled furnace roof and air-cooled firing wall. Maximum flexibility in the selection of firing and control equipment match the most exacting demands of industry.

**The Type AS Superior Packaged Boiler** brings to small steam plants the basic advantages of water tube boiler performance. Eliminating the problems resulting from compromising existing designs . . . shortened and baffled to provide lower capacities and required transfer rates . . . the Type AS is specifically designed for the 4,000 to 21,000 lbs./hr. range, incorporating not only features of larger units, but with exclusive features which will be adapted to units of greater capacity.

To provide true power plant performance over the wide range of capacities for which packaged boilers are today specified, Superior offers two basic designs. *No single* design can encompass this entire range without compromise. Both of these designs are true packages . . . completely factory assembled, factory-fire-tested and backed by unit responsibility.

Whatever your capacity requirements, you can specify a Superior Packaged Boiler without compromise. Careful comparison will prove that no other product offers so much. Our engineers are available to help you make that comparison. You'll profit by seeking their assistance.

For complete details of Type D, write for Catalog D-11.
For complete details of Type AS, write for Catalog 11S.

Specialists in PACKAGED BOILERS... exclusively

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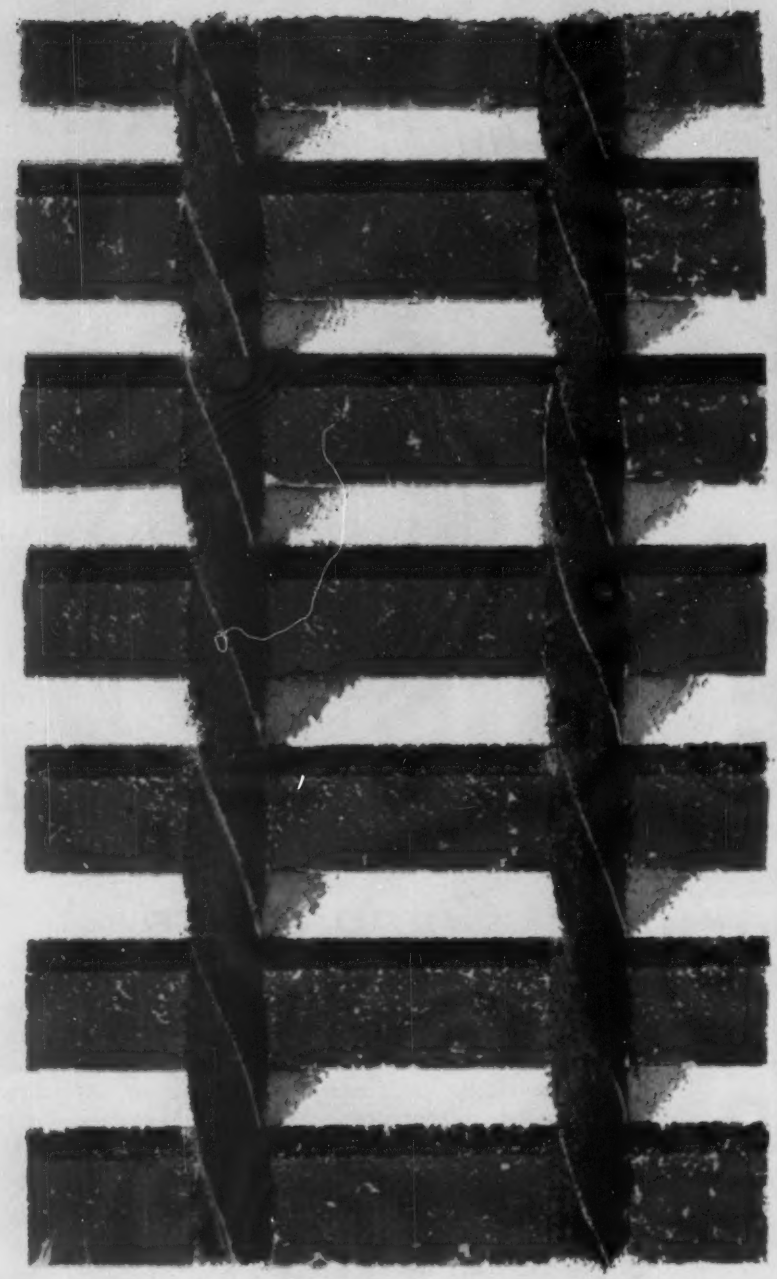
SUPERIOR PACKAGED BOILERS



For more facts circle 285 on Reader Service card, p 133



**Blaw-Knox Electroforged Grating solves so many problems for so many industries.** Catalog free on request. Write

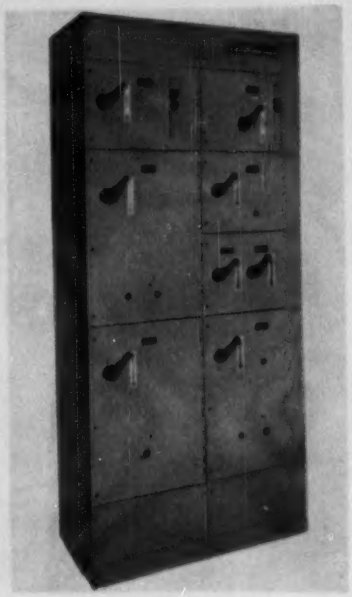
Blaw-Knox Equipment Division, Pittsburgh 38, Pennsylvania.

**BLAW-KNOX**

*GRATING*

## Equipment news

Begins on page 148



### Control center

**27** • Control is for use in generating stations. It provides for group control of motors through 200 hp. Centralized in one group of standardized enclosures about 90-in. high, controls are accessible from front and all wiring is accessible through hinged, full-length rear doors. Steel barriers isolate full-length rear wiring compartment from vertical bus. —Westinghouse Electric Corp

Just circle key numbers on the Reader Service card, page 133, to get complete product story

### H-v air silencer

**32** • Silencer is absorption type having perforated air-passage tube entirely enclosed by sound-absorption material encased in outer shell. Designed for easy installation on heavy-duty applications, unit is leak resistant with continuous welded seams, double-seal crimped ends and female pipe connections on both ends. You can use it for temperatures up to 210 F, says maker. — Universal Silencer Corporation

# GET THAT BETTER PUMP FOR YOUR NEW BUILDING

PEERLESS PUMPS

## *Why the AquaLine for your job?*

*Fast, Easy Installation*—Peerless AquaLine pumps install quickly in new or existing systems. No special tools are required. Take it out of the package and put it to work.

*Compact, Space Saving* — Sealed type AquaLines require only one-half the space of other type pumps. Even the packed types are streamline and compact, permitting efficient space-saving layouts.

*Easy to Maintain* — AquaLine's horizontal split-case design affords quick inspection of rotating parts without disturbing piping. Parts lift out for easy replacement, materially reducing down time.

*Immediate Availability*—All sizes of pumps and parts are stocked for rapid delivery. You get the pump you want when you need it—ready to unpack and install.

*Low in Cost, High in Quality* — Peerless AquaLine pumps are engineered with the same high-quality traditionally found only in more expensive units. Yet this pump is priced right. Get the facts. Send for Bulletin B-2100 today.

**FOR EFFICIENT DEPENDABLE WATER HANDLING SPECIFY THE NEW PEERLESS *AquaLine* PUMP**

**AquaLine Characteristics:**

**Sizes: to 8 inches** **Capacities: to 2600 gpm**
**Heads: to 280 feet** **Temperatures: to 250° F**

**ATTENTION DEALERS:** A few choice dealerships are available for the Peerless AquaLine Pump. Write us for more details.

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For more facts circle 287 on Reader Service card, p 133

Ask the thousands of engineers who use CHESTERTON "64" STEAM PACKING

and they'll tell you...

1 "64" gives three to five times longer service because of its patented diagonal construction which permits many more "take ups" as it wears.

2 "64" stays resilient where other steam packings grow hard (because of "64"'s special heat resisting compound).

3 "64" costs less because it weighs 20% less and gives more feet to the pound (due to lighter weight of "64"'s non-vulcanizing compound).

WHICH MAKES SENSE TO YOU?

THIS:

OLD FASHION RUBBER BACK WHICH BURNS OUT

1. Has parallel plies of Asbestos which do not respond to gland or service pressure.
2. Requires a rubber back for expansion which fails on high heat.
3. Packing grows rock hard in service because of rubber cement between laminations

CONVENTIONAL PACKING HARDENS!

OR THIS:

NO WEAK RUBBER BACK

"64"

1. Has diagonal rather than parallel ply construction for self sealing action.
2. Remains soft and pliable in service because laminating compound resists hardening.
3. Old fashioned rubber back eliminated by giving expansion through patented diagonal design.

CHESTERTON "64" STAYS SOFT AND PLIABLE!

PACKING Chesterton SERVICE

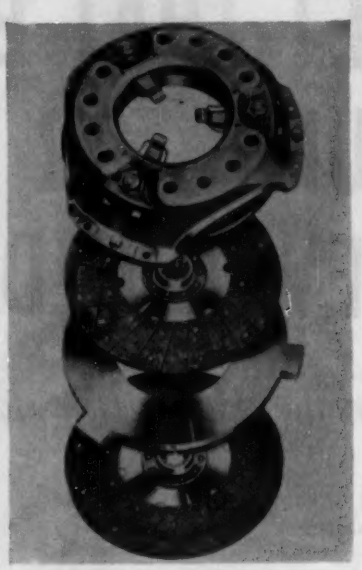
You can purchase Chesterton "64" from any one of 300 local distributors. Write for catalogue and name of nearest Chesterton distributor.

A. W. CHESTERTON CO., 7 ASHLAND ST., EVERETT 49, MASS.

America's Oldest Manufacturer of Mechanical Packings


## Equipment news

Begins on page 148



### Heavy-duty clutches

21 • Complete range of direct-pressure heavy-duty clutches with torque capacity from 200 to 1400 lb-ft features high mechanical efficiency. According to maker, clutches have needle-bearing friction-free internal-lever-linkage system to provide this efficiency.—Lipe-Rollway Corp, Clutch Div

Just circle key numbers on the Reader Service card, page 133, to get complete product story

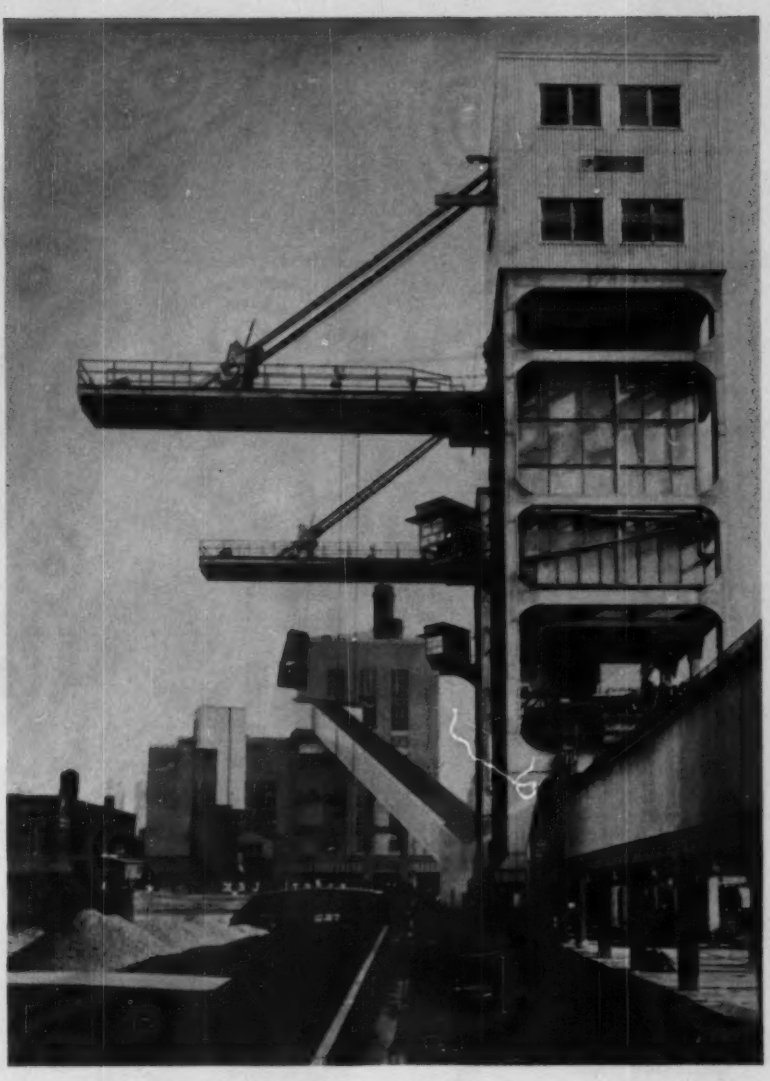
### Solar cells

13 • Solar cells with 10% minimum conversion efficiency are now available. High-efficiency cells measure 0.4x0.8 in. They range from 4000 to 11,500 angstroms; operating temperature range is −65 to 175 C. —Hoffman Electronics Corporation

### Hermetic chiller

26 • Centrifugal water chillers fill any air-conditioning or process-cooling requirement, says manufacturer. Integral-fabricated water boxes give higher impact strength, improved

# Complete Coal Unloading by H&P



*Unloading Towers at the 59th Street Station. One of Consolidated Edison Company's stations supplying power to the New York subway system.*

**In recent years, Heyl & Patterson has built 16 Unloaders with free-digging rates from 390 to 1350 TPH for 11 Utilities and Industrial Power Plants.**

**Keeping step with the trend for larger coal burning units, H & P has on its drawing boards a completely new design featuring an economical Barge Unloader of about twice the capacity of anything in existence.**

***When your plans call for high-tonnage coal handling facilities . . . ask us to demonstrate to you the cost-saving advantages of this new concept of unloading bulk materials.***

**In over 70 years, H & P has acquired a reputation for building reliable equipment. Let us assist you and your Consulting Engineers in developing the most practical method of handling your bulk materials. This may involve Boat and Barge Unloading, Rotary Car Dumping, specialized Conveying and Processing Equipment.**

***Heyl & Patterson's fully integrated operations can give you a "turn-key" job—second to none.***

**And always remember—**

***When Experience Counts... Count on Heyl & Patterson***

**HEYL & PATTERSON, inc.**

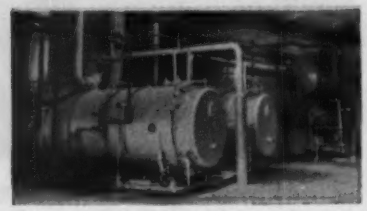
55 FORT PITT BLVD., PITTSBURGH 22, PA. • COurt 1-0750



For more facts circle 289 on Reader Service card, p 133

# 1st choice for steam in world's largest dome

**Matched pair of 200 hp Cleaver-Brooks boilers picked to supply steam for cleaning tank cars and for heating, too, at Union Tank Car's great new repair center in Baton Rouge, Louisiana**



This fabulous structure houses the most modern of tank car repair facilities. The two Cleaver-Brooks packaged boilers provide low-cost process steam for cleaning tanks — eliminating residual acids, volatile and tenacious liquids or near-liquids.

Their high-capacity performance not only meets the demands for efficiently produced steam for cleaning (guaranteed 80%), but also provides steam for heating.

Because of packaged design, the two 200-hp units (delivering 150 lbs. pressure) were easy to install, occupy minimum floor space. And the boilers are fired by either oil or gas . . . thus, providing operational flexibility regardless of available supplies.

So far, Union Tank Car has used steam from the Cleaver-Brooks boilers to clean out cars that have transported petroleum products, chemicals, coal tar products, vegetable oils and liquid fertilizers.

The choice of the Cleaver-Brooks boilers was underwritten by their combination of remarkable compactness, automatic operation, wide-range flexibility and around-the-clock reliability.

If you'd like to know more about this installation or how Cleaver-Brooks packaged boilers (15 to 600 HP) fit into your expansion or replacement plans, write Dept. D, 301 E. Keefe Ave., Milwaukee 1, Wisconsin.

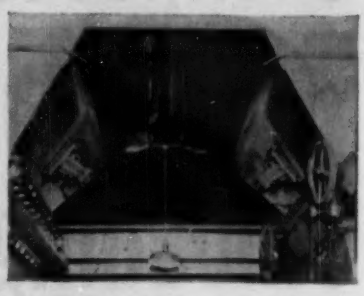
Cleaver Brooks®

*ORIGINATOR AND LARGEST PRODUCER OF PACKAGED BOILERS*


## Equipment news

Begins on page 149

connection flexibility and less leakage. Adaptable as a heat pump, unit is said to chill water down to 40 F. —The Trane Company



### Air vibrator

**36** • Long-stroke air vibrator for coal-handling operations is said to dislodge arched material with a direct-timed long-piston stroke. Vibrator has 1-piece design that should cut vibrator-maintenance downtime and repairs. Piston is only moving part. Unit can be used under extreme moisture conditions and in locations where magnetic dusts exist. — National Air Vibrator Company

Just circle key numbers on the Reader Service card, page 133, to get complete product story

### Ball valves

**29** • Ball valves are designed to reduce initial in-place and valve-maintenance cost. They provide full flow tight shut-off and quick quarter turn, maker claims, feature 2-way flow, minimum pressure drop and self-adjusting seats. No lubrication is required. Valves are noncycling.— Hills-McCanna Co

### Lubricant spray

**20** • Lubricant in spray-on container is said to increase open-chain life 300%. It offers faster and easier application to conveyor and transmission chains of all types. Lube was developed to work into close-toler-

# Have you ever been troubled by any of these steam trap problems?

## ARMSTRONG STEAM TRAPS are designed and made to eliminate these problems

**BACK PRESSURE** . . . Armstrong Traps operate on any back pressure—or vacuum, for that matter. As long as there is a pressure differential across the trap, it will close on steam and open for condensate. Even the high back pressure caused by blow through of one or more traps in the system will not disturb Armstrong Traps. Other than a reduction in capacity, Armstrong Traps are unaffected by back pressure.

**DIRT** . . . Armstrong Traps are not affected by ordinary dirt. When the trap opens condensate swirls down under the edge of the bucket and up through the discharge orifice. Dirt is kept in suspension and discharged along with the condensate. For very bad dirt conditions, Armstrong offers traps with integral strainers. These cost less than a trap plus a separate strainer.

**AIR BINDING** . . . Armstrong Traps cannot air bind. Air in the system passes through a vent in the top of the bucket. It collects in the top of the trap and is discharged with the condensate. There is no chance for it to stop the trap. For low pressure on-and-off units where large amounts of air accumulate while the steam is off, Armstrong offers open float and thermostatic air vent traps in a complete range of sizes.

**WIRE DRAWING** . . . Armstrong Traps are designed and made to resist wire drawing. The valve and seat are tough stainless steel. The valve opens and closes tightly with a fast action and is always water sealed. There is virtually no chance for grit or sediment to lodge in the valve, virtually no chance to create conditions that lead to wire drawing.

*There's no need to accept any of these problems as "inevitable." Your local Armstrong Representative can show you how to end them all. Call him today or write direct.*

860 Series for low pressure heating service.

800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.

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For more facts circle 291 on Reader Service card, p 133

# When You Need the RIGHT RING!

Allpax is the answer because Allpax can supply the right ring for each packing requirement whether it be on valve or pump. We make the right kind!

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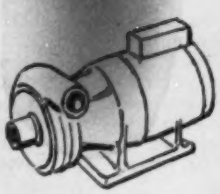
✓ ***For manufacturers —***

Allpax Rings cut costs and do a better job because they are precision-made in a complete range of sizes and a wide variety of materials. Right types available for each pump or valve requirement for whatever material handled.

✓ ***For replacement —***

Accurate dimensions and proper types make replacement easier — insure a tight seal without danger of scoring or unnecessary wear on shafts or valve stems.



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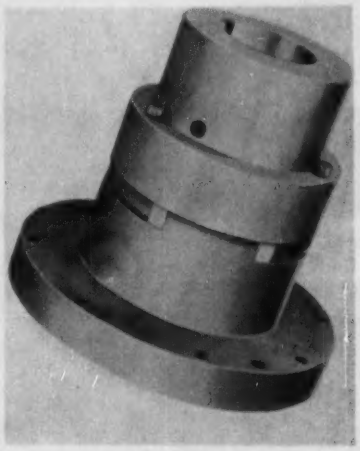
## Equipment news

Begins on page 148

ance internal-friction surfaces of open chains between bushings and pins or bushings and rollers to reduce wear and dissipate heat. It features built-in corrosion inhibitor said to limit rust and corrosion of costly open chain.—Whitmore Mfg Co



### Heavy-duty coupling

**23** • Flange type coupling is for heavy-duty use on internal-combustion engines where coupling must be bolted directly to flywheel. Coupling consists of two metal bodies with interlocking jaws separated by nonmetallic load cushions. Removable, individual inserts held in place by a steel collar provide easy inspection or replacement without disturbing driving. No lubrication is required. —Gerbing Mfg Co

Just circle key numbers on the Reader Service card, page 133, to get complete product story

### Epoxy fittings

**37** • Fiber-glass-reinforced epoxy fittings are said to offer good resistance in transfer of wide range of corrosive liquids. Epoxy fittings and pipe operate to 350 F and 150 psi. They come in sizes from one through six in.—Ed Conley Plastic Corp

continued

# FIRST

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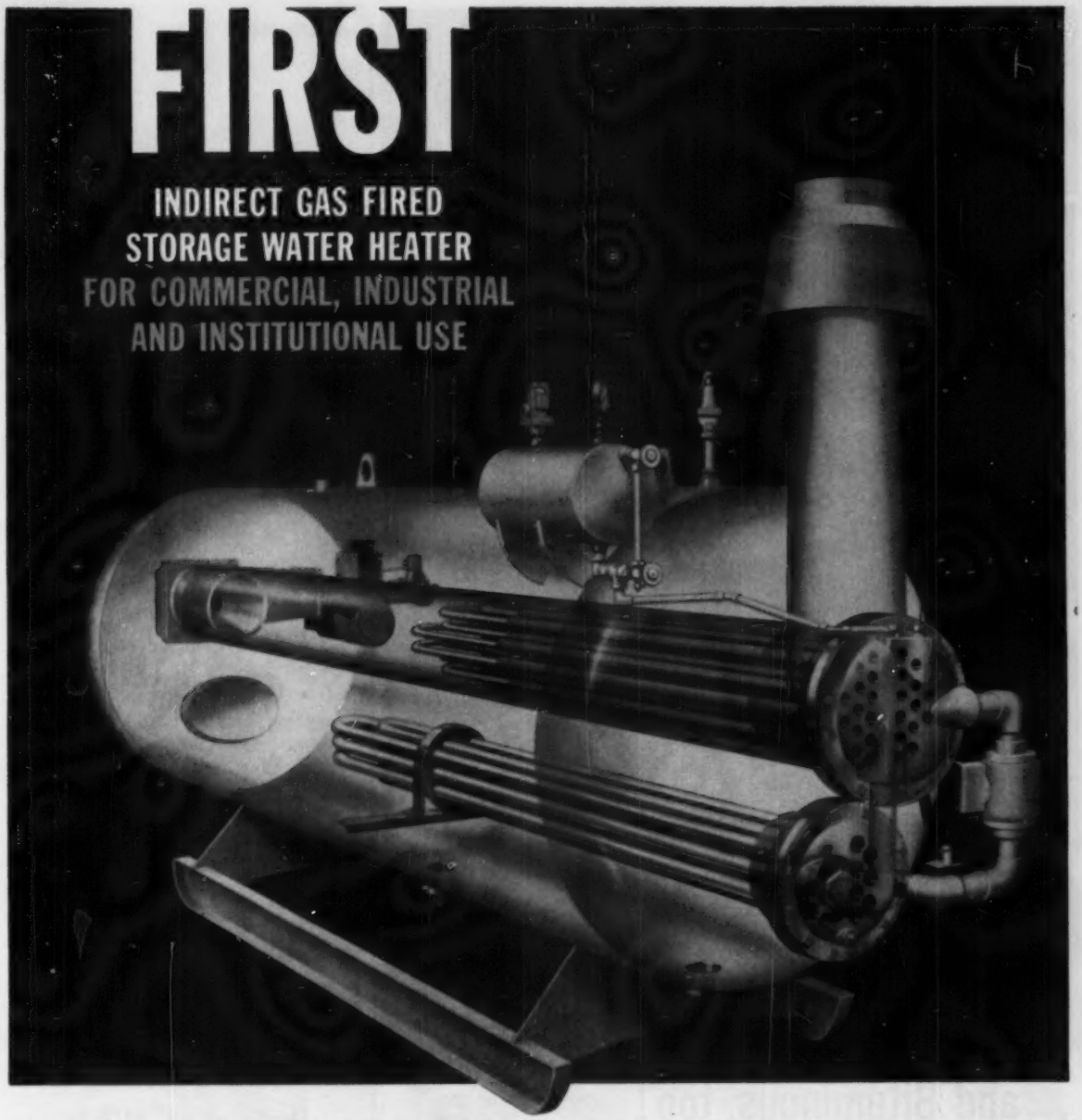

*No scaling · No drop-off in rated efficiency · No fuel waste · No on-the-job assembly · No complicated maintenance · No limitations on placement · Fully automatic · Copper heating surface*

**P-K SCALEFREE 230*** is a unique rugged unit backed by P-K's 80 years of experience in building and designing quality water heating equipment. It heats water through hot intermediate distilled water. Transfer occurs below the temperature at which minerals that cause scaling precipitate. Efficiency remains unimpaired throughout service life. Linings of pre-Krete or copper are available to keep the unit free of rust and corrosion regardless of water conditions.

**SCALEFREE 230** features a new P-K gas burner. It operates at maximum practical efficiency. Yet it gives almost noiseless service—does not rumble or boom on startup. This permits location almost anywhere in office buildings, institutions, schools, motels, etc.

**SCALEFREE 230** is a complete fully automatic package that can be quickly set in place, hooked up and checked out. It is available in more than 100 storage and recovery combinations. Storage capacities range from 250 to 4000 gallons. Recovery sections range from 390,000 to 2,215,000 Btu. Write for catalog with full information.

*Patent pending

**Patterson Kelley**
104 Morgan Ave., East Stroudsburg, Pa.



For more facts circle 293 on Reader Service card, p 133

# IT'S *what's behind* THE BALL THAT COUNTS!

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## Equipment news

Begins on page 148

### Five-oz Geiger counter

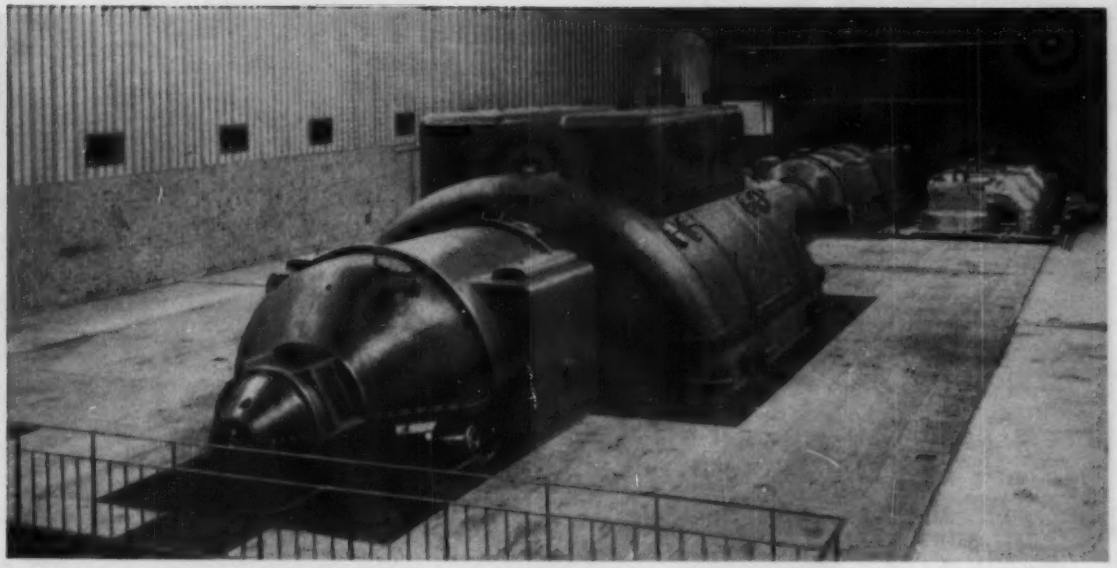
**16** • Transistor Geiger counter weighing only five oz gives instantaneous radiation warning, says maker. Instrument is small enough to fit in the palm of your hand. Worker can slip it into his pocket and always be on guard. Operating on small flashlight batteries, unit needs no expensive wiring or materials.—Gelman Instrument Co

Just circle key numbers on the Reader Service card, page 133, to get complete product story

### Do-it-yourself carbides

**31** • Carbides may be machined, offer unusual resistance to heat and moisture, says maker. Carbide parts and tools to withstand high temperatures and corrosive media may now be produced right in the shop. Only conventional tools are needed to machine the new material.

Steel-bonded carbides come in two grades, both produced by powder-metallurgy techniques, embedding tiny crystals of extremely hard titanium carbide in soft matrix of stainless steel. Applications include valves, valve seats, pump seals and high-temperature bearings.—Chromalloy Corp, Sintercast Div



*150,000 kW double rota ion turbine, one of two in the Stenungsund plant of the Swedish State Power Board.*

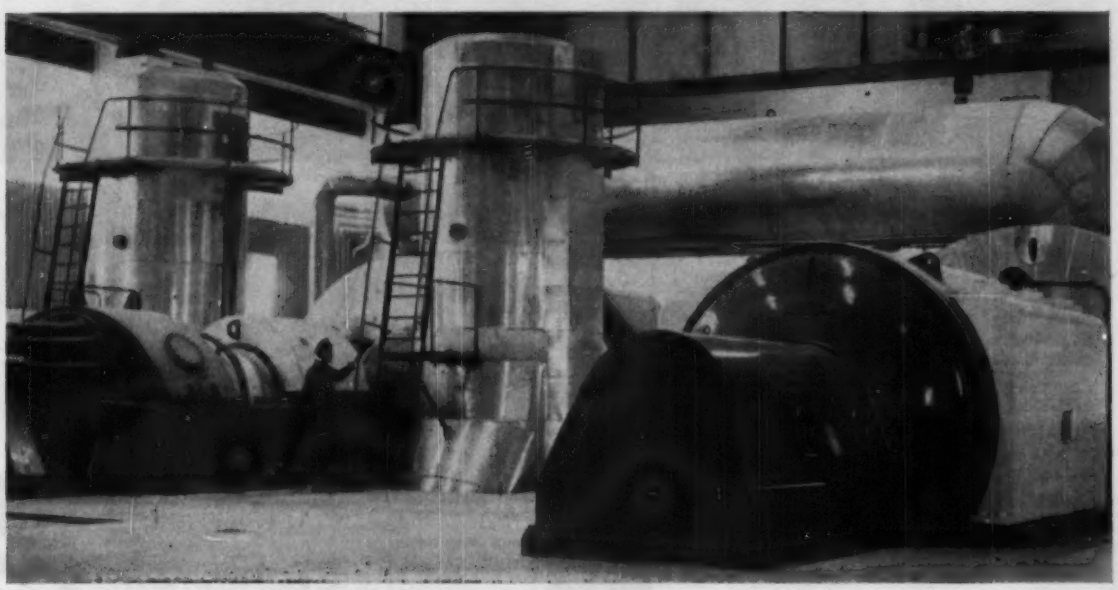
# Largest in the world

**The largest gas turbine in the world and the largest double rotation turbine are only two steps in the recent technical progress at de Laval Ljungstrom. Steam turbines for 300,000 kW (at 3,000—3,600 rpm) are already on the drawing board.**

**New designs, as the Durax and Quad, have eliminated earlier size limitations. As well, the double rotation system offers considerably lower transport weights than conventional designs. Further, appreciably higher efficiency figures have now been attained.**

**The recently amalgamated de Laval Ljungstrom companies now offer in 49 countries a complete programme of axial and radial turbines for land and marine applications, together with refrigerating equipment, high-precision gearing and pumps.**

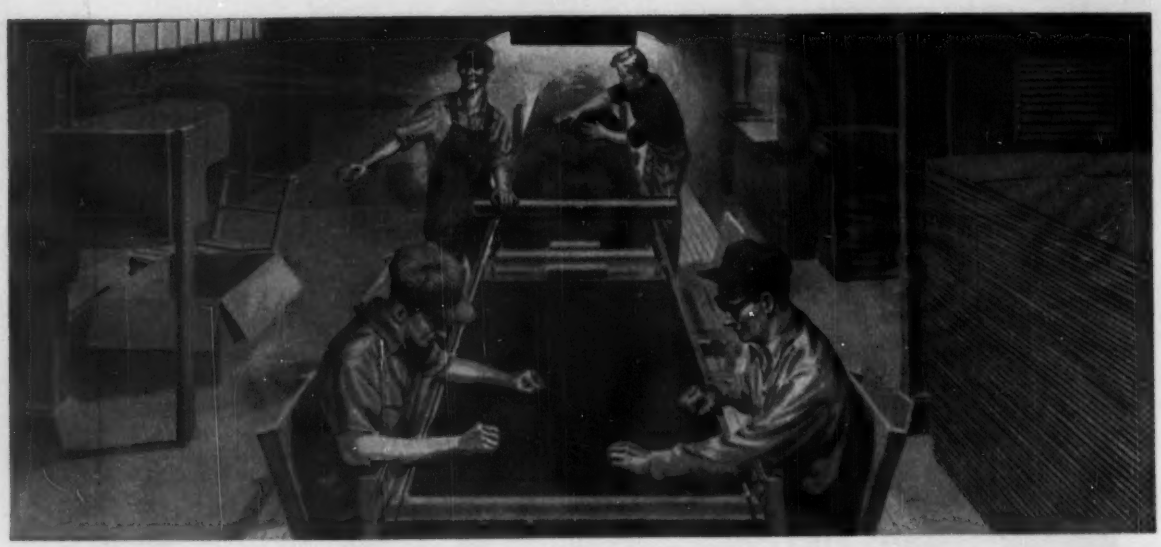
*World's largest gas turbine, for 40,000 kW, in the Västervik plant of the Swedish State Power Board.*



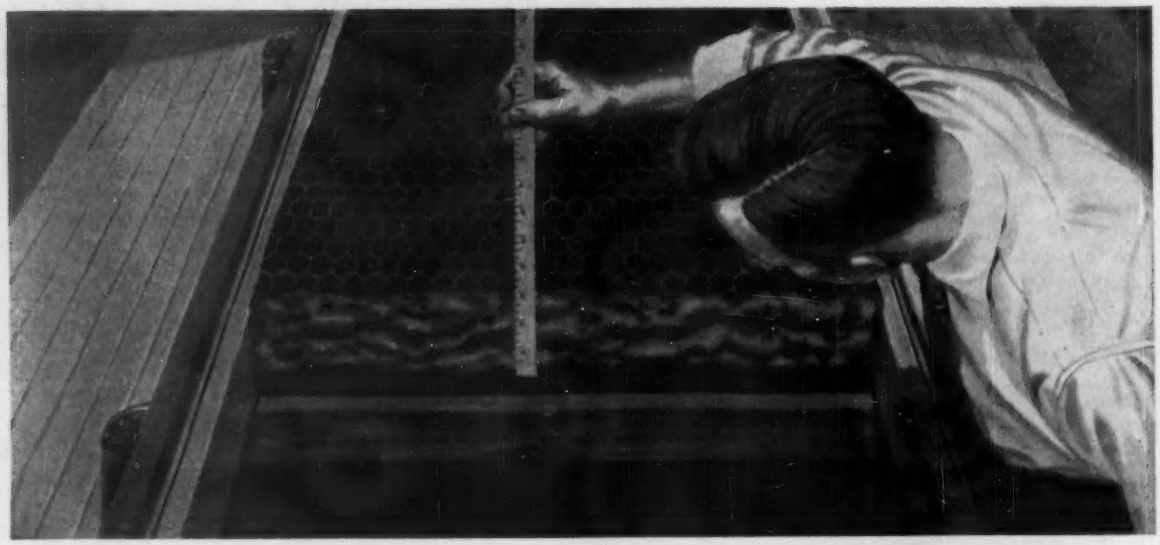
**DE LAVAL LJUNGSTROM TURBINE CO** • *Finspong* • *Sweden*



For more facts circle 295 on Reader Service card, p 133



# FACTORY FABRICATED TO RIGID SPECIFICATIONS!



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- Copper bearing steel laths, bound by uniformly spaced soft-drawn galvanized tie wires, keep blankets firm but flexible.
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- Completely free of large voids usually found in field-made blankets where insulation is haphazardly packed in place.
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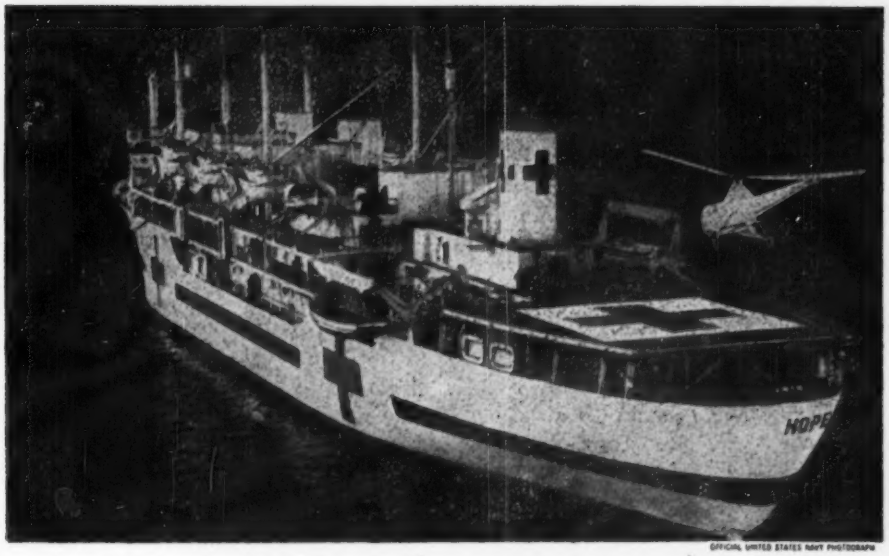


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This great seaborne health center will carry a new kind of aid abroad—*with your help.* Part of the people-to-people project Hope, it will enlist 200 specialists in sharing our health skills.

Ambassador with a blackboard, the Hope specialist will help the often woefully few local medical technicians train helpers. The result: many more hands. And that means one Hope dollar is multiplied many times over.

# YOUR HELP CAN COME BACK A HUNDRED TIMES OVER

One local doctor for 100,000 people. These are the odds Hope may face. Yet Hope can mean so much. The health of this child. The health of five Indonesians. *Trained* hands and only a dollar's worth of penicillin can cure them of crippling yaws.

If enough of us help, the S.S. Hope will be outbound in 1960. First port of call: Indonesia. A bold health project called Hope will be underway.

The need is crucial. Many places, too many health hazards exist. Too many people robbed of the will to live. Too few hands to help. Often, a doctor for 100,000.

Hope's approach is *practical.* Help where a nation's doctors ask help. Help them help themselves to health. By training, upgrade skills—multiply hands. Hope's doctors, dentists, nurses, and technicians will man a center complete to 300-bed mobile unit and portable TV.

You can not only make every dollar do the work of many, you can earn a priceless dividend. With health comes self-respect. People at peace with themselves are less likely to war with others.

Hope is *yours* to give. It's a people-to-people project. For one year's worth, 3½ million Americans must give a dollar. Don't wait to be asked. Mail a dollar or more now to HOPE, Box 9808, Washington 15, D.C.

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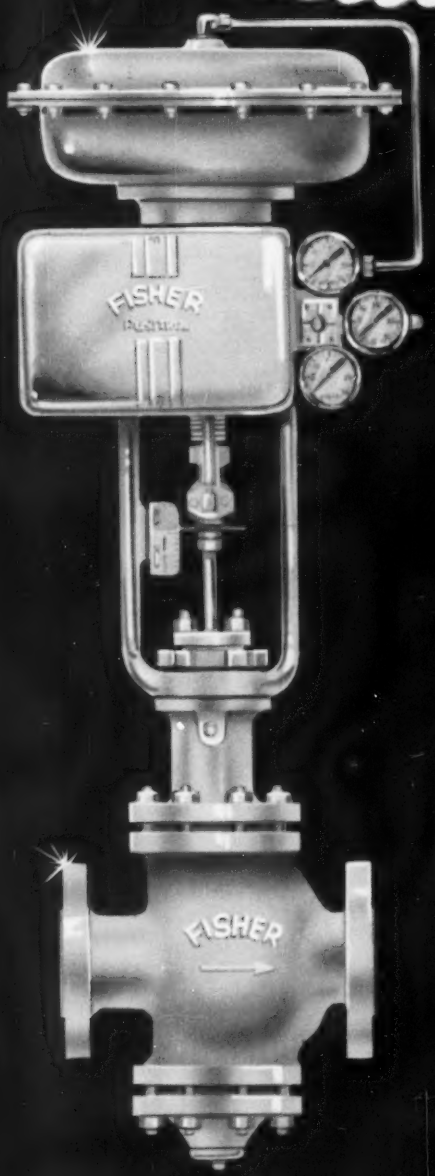


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# . . . *could increase the value of a* FISHER DMV!

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These are the factors that represent your real assurance of trouble-free performance in Fisher control equipment. They are also the factors that have made Fisher control valves the standard throughout industry for nearly half a century.

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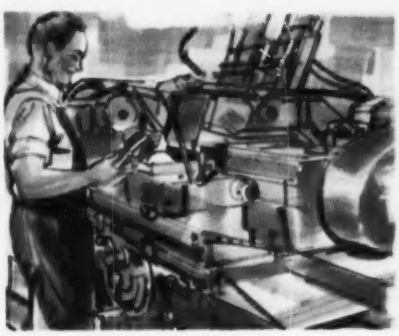

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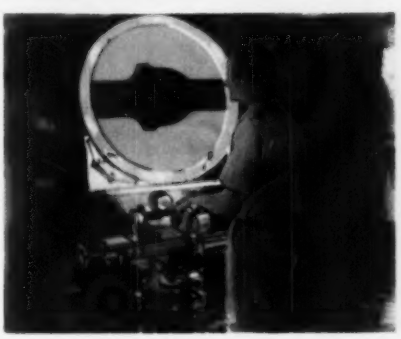
This machine, the latest in precision grinders, produces a super-finish on all valve guides and bushings. It is just one example of combining modern machine tools and the skill of experienced Fisher craftsmen to assure accuracy of control and long, trouble-free field operation.



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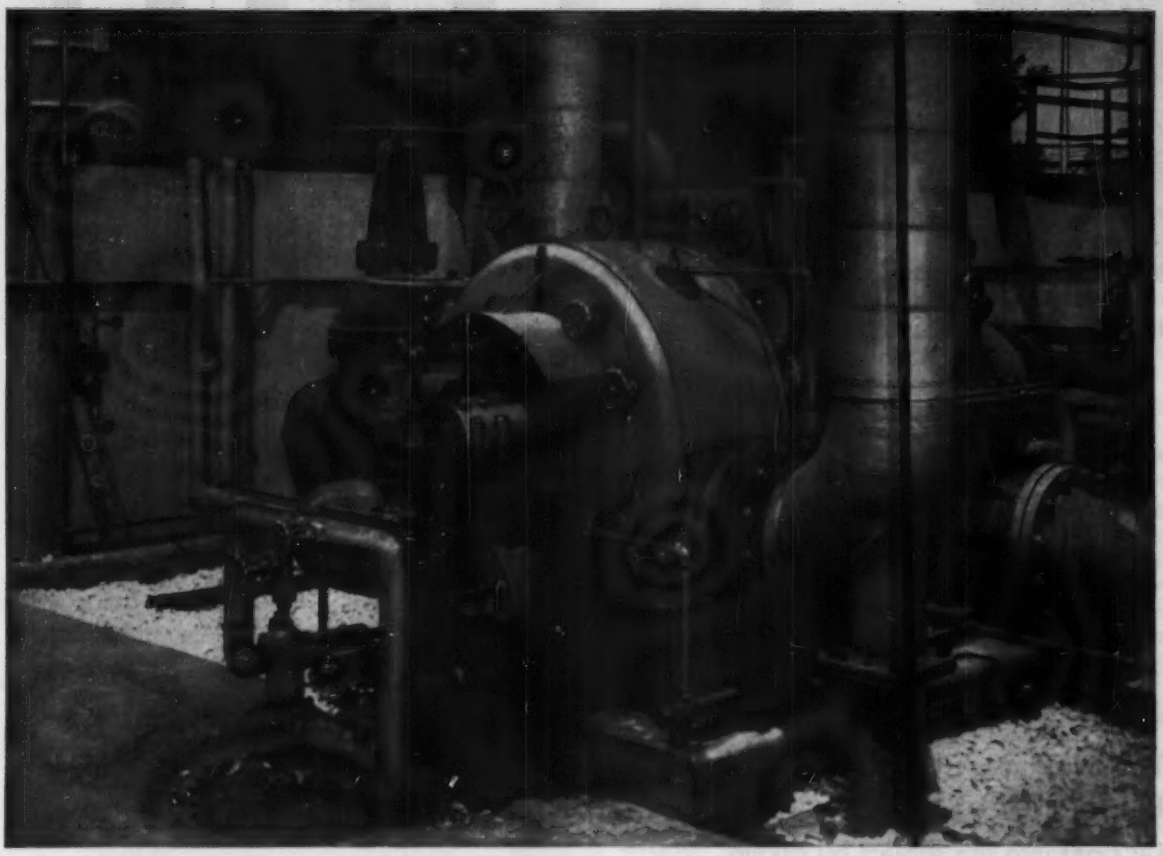
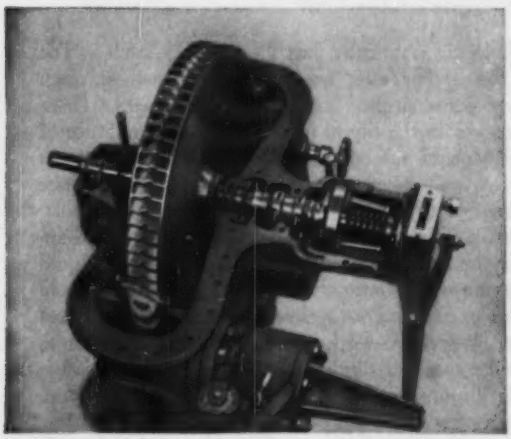


# TERRY SOLID-WHEEL TURBINES

*used exclusively at Baton Rouge plant of W.R.Grace & Co.*



The upper photograph shows one of the 17 Terry turbines installed at the Baton Rouge, La., GREX high-density polyethylene plant of W. R. Grace & Co. Above, a typical Terry solid-wheel turbine with cover removed to show the wheel construction.

In purchasing equipment for their new 50,000,000-pound high-density polyethylene plant, W. R. Grace & Co. standardized, wherever possible, on a single source of supply for each type of equipment used. Consistent with this policy, Terry steam turbines were used exclusively throughout the utility and process sections of the plant.

A total of 17 turbines were placed in service for driving pumps and fans. These are all of the solid-wheel type, ranging in capacity from 50 to 240 HP.

Terry solid-wheel turbines are known for their long life and sure dependability under the most-trying operating conditions. They feature a single-piece wheel which is virtually indestructible.

Send for details of these trouble-free turbines. Ask for a copy of bulletin S-116.

**THE TERRY STEAM TURBINE COMPANY**
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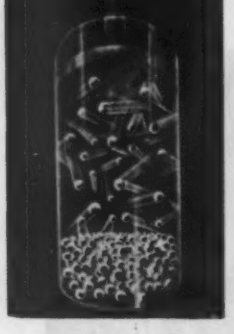
TERRY

TT-1214



THERMO REFRESHER NO. 37

By B G A SKROTZKI
Associate Editor

**1** Confining a piece of ice in a cylinder and piston under constant pressure while heating it lets us study how it changes phase from solid (a) to a mixture of solid and liquid (b), then to all liquid (c) and on to a mixture of steam and liquid (d). Continued heating forms saturated steam (e) and finally superheated steam (f). If we make pressure *P* low enough we sublimate ice directly to steam at low temperature (g)

**Vapors do much of the world's work, plus space and process heating. Today we use many types of vapors for special jobs. Let's get into this subject by asking . . .**

# Why does steam act that way?

Now that we understand behavior of ideal gases and their use in thermodynamic cycles, we are ready to study vapors. To start, let's review the molecular theory of solids, liquids and vapors. This will help to understand the peculiar behavior of vapors, see Part 1, POWER, Aug 1956, pp 98-100 and Part 6, Feb 1957, pp 86-89.

**Water** is the working fluid most used in power cycles, so let's find out how it behaves in its three phases. In Fig. 1*a* we start with a block of *supercooled* ice at temperature $T_1$ (below 32 F) completely filling the cylinder and held under a pressure $P_1$ by a piston pressing on it.

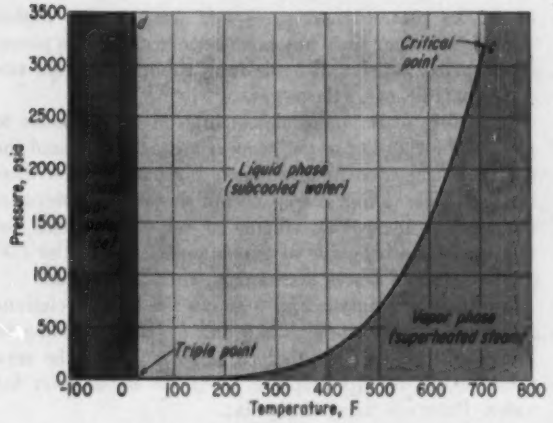
Sketch shows schematically that molecules of water in solid phase hang in space, held there by mutual forces of attraction and repulsion. The kinetic energy of the molecules keeps them bouncing around, each in its own general location. But their energy is not enough to make them break away from the balanced restraining forces acting on them.

**Melting.** In Fig. 1*b* we add heat $Q_1$ to the ice to raise its temperature to $T_2$. Some of the molecules absorb more of this energy than the others (Maxwellian distribution), so their increased kinetic energy lets them break away from the mutual forces acting at one location and they start wandering erratically past the other molecules. The mutual forces they meet everywhere pull them through haphazard paths as they wander through the ice. These molecules are in the liquid phase; we have a mixture of *saturated* ice and water in Fig. 1*b*. Average temperatures of the ice and the water are equal, even though the phases are different.

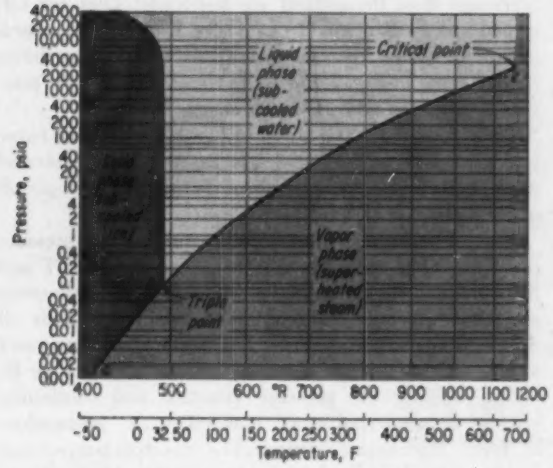
This may seem paradoxical, but let's study what happened. In changing phase from solid to liquid, the liquid molecules absorbed more energy than their slower neighbors. But in breaking away from their restraining forces they did mechanical work. This slowed them down to the *average* speed of the ice molecules, but having overcome the initial "inertia" they now can move around.

While a mixture of saturated ice and water is heating, the temperature stays constant, usually at about 32 F. Energy used to make this change of phase is the *enthalpy of fusion*, and represents work done by molecules in breaking away from their fixed locations in the solid.

In Fig. 1*c* we add more heat $Q_2$ and melt all the ice to water; when it has all changed to liquid phase, heat addition makes the temperature rise to some temperature $T_3$. Water is now a *subcooled* liquid. The molecules all




**2** Pressure-temperature diagram shows their relation for changing the phase of water from solid to liquid to vapor at will




**3** Logarithmic plot of Fig. 2 gives more accurate readings of both pressure and temperature at the extremes of their values

wander among each other like a swarm of angry bees. Their mutual forces of attraction are strong enough to hold them in one mass at the bottom of a container. The molecules at the surface of the water have attractive forces acting on them tending to pull them into the body of water. This compacts them and produces *surface tension:* the effect that allows a needle to float on the surface of a liquid.

**Vaporizing.** In Fig. 1*d* we add heat $Q_3$ to the water and start boiling off some of the water to vapor or steam. During this heating, at some temperature $T_4$ (depending on value of $P_1$), some of the molecules absorb more energy than others. This lets them break away completely from the liquid molecules to soar above them and form steam.

Again we find that *average* temperature of the steam molecules and the liquid molecules is the same. This mixture of *saturated* steam and water does not change its *saturation temperature* while the water and steam are being heated and are in contact with each other. During this *evaporation* process the faster steam molecules do work in breaking away from the attractive forces of the water molecules. This slows them down to the same average temperature (speed).

Work done by the escaping steam molecules is the *enthalpy of evaporation.* In most cases, steam forms as bubbles within the water being heated, at the heat-transfer surface. When the bubble becomes large enough it breaks away from the heating surface and rises through the water. At the top surface it breaks through and joins the steam accumulating above the water.

In Fig. 1*e* heat addition $Q_4$ evaporates all the water to steam, the water just having disappeared. It is now all *saturated steam* at temperature $T_5 = T_4$. Adding some more heat $Q_5$ in Fig. 1*f* raises the temperature to $T_6$ and we have a *superheated* vapor. As a vapor the molecules are close enough together to still exert slight attractive forces on each other. But if we continue superheating we eventually expand the volume of the steam and raise its temperature enough so that it acts very much like a perfect gas.

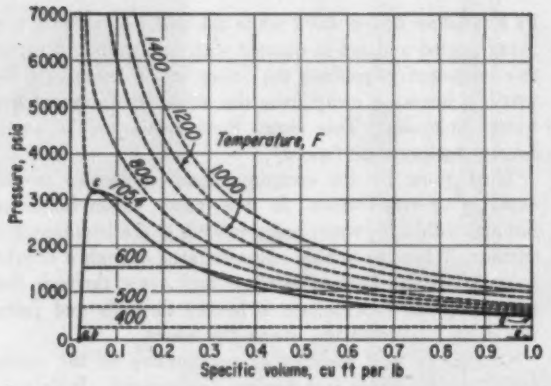
**Condensing.** Changing the phase of a substance is a reversible process; by adding or taking away energy as heat or by changing pressure we can make a substance change to any phase wanted. For instance, in Fig. 1 we can start with the superheated vapor in *f* and by taking away heat $Q_5$ we can get the saturated vapor in *e*, at temperature $T_4$.

Further cooling by removing heat $Q_3$ in *d* makes some of the saturated steam condense to saturated water. That is, some of the steam particles slow down enough so that the mutual attractive forces bind them together loosely to form water. Removing heat $Q_2$ in *c* condenses all the steam and cools the liquid to a *subcooled* water. In *b* removing heat $Q_1$ makes the water freeze to ice. Again removing the kinetic energy of the water molecules slows them down to the point where balanced attraction and repulsion forces hold them in one general location to form a solid. Further heat removal subcools the ice and lowers its temperature to $T_1$, which simply reduces the vibrations of the ice molecules.

**Sublimation.** We can make a solid evaporate directly to its vapor if we establish the proper temperature and pressure. In Fig. 1*g*, by making both pressure $P_s$ and temperature $T_s$ low enough, we can make ice sublimate to steam. This would be a mixture of saturated ice and steam. Here when the solid molecules break away from their bonds they have enough energy to soar into space without going through an intermediate liquid phase.

***P-T* relations.** If we change the pressure on piston in Fig. 1 we will find that temperatures at which the ice melts and the water boils will be different. Volume changes will also be altered. These relations can't be expressed simply by formulas so we most conveniently show them by graphs, Fig. 2 and 3.

Both figures have the same data; Fig. 2 is on arithmetic coordinates and Fig. 3 on logarithmic. Suppose we had our ice initially at 500 psia and –100 F. This would be subcooled in the solid phase, but as we heated




**4** Pressure-volume diagram for steam shows that it acts much like a gas at the higher temperatures, but not at low values

it to 32 F we would find it melting to water, indicated by line *bd*. This curve is the locus of melting while heating, or fusion while freezing. All mixtures of saturated ice and water lie on this vertical curve. When we work with pressures above 3000 psia the freezing or melting temperature drops lower than 32 F.

Returning to our 500-psia heating: when all the ice has melted, the water rises in temperature into the subcooled-liquid region. When it reaches 467 F it changes phase by starting to boil. This lies on the curve *bc*, which is the locus of all saturated-water-steam mixtures for pressures up to 3206.2 psia.

When all the water has boiled to steam the temperature rises and the steam enters the superheated-vapor phase. As it continues heating, steam enters the gas phase. This has no definite boundary, simply meaning that the steam behaves nearly like a perfect gas, its state being predictable by the perfect-gas equation.

**Low-pressure heating.** If we drop our pressure on subcooled ice to 0.04 psia and start heating the ice, it vaporizes at about 27.5 F to steam. After complete vaporization further heating produces a low-pressure superheated steam. This can be most clearly seen in Fig. 3.

Point *b* is the *triple point* for water. Saturated ice, saturated water and saturated steam can all exist simultaneously in a mixture only at 32.02 F and 0.0888 psia. Along curve *ab* ice sublimes to steam or in reverse steam freezes to ice, and as you see, only at very low pressures and low temperatures.

**Critical point.** Now let's look at a high-pressure process. Under a pressure of 3206.2 psia, heating subcooled ice will make it start melting at about 29 F. When it has all melted, further heating raises the temperature of the liquid. At this pressure (and higher) we never reach the boiling point. On a purely *arbitrary* basis, when we reach the temperature 705.4 F at point *c* we call anything hotter a superheated steam, anything cooler a liquid or water.

Point *c* is called the *critical point* for steam, at the *critical temperature* of 705.4 F and the *critical pressure* of 3206.2 psia. At pressures and temperatures higher than these, water does not experience a change in phase, liquid being indistinguishable from vapor. The fluid acts somewhat like a very dense gas.

Crowding of the molecules at high pressures seems to prevent their ability to get away from each other and the mutual forces of attraction play a big part in their thermal behavior. These graphs do not show the accompanying changes in specific volume of water and steam, so let's study the behavior of water and steam on the *P-V* graph—area measures mechanical work transferred.

**Volume changes.** Fig. 4 shows the *P-V-T* relations for water and steam. Points *a* and *b* (corresponding to Fig. 2 and 3) are essentially a single point on the zero pressure line in this graph, *b* being the triple point for water. Point *c* is the critical point.

Curve *bc* is the locus of all saturated-water states. Curve *cg* is the locus of all saturated-steam states. The dashed lines are constant-temperature lines. Temperatures less than the critical are horizontal lines for saturated-water-steam mixtures. There is only one *saturation temperature* for each pressure; this was also shown by curves *bc* in Fig. 2 and 3. In these relations the pressure is called the *saturation pressure*.

Let's study the 500-F curve in Fig. 4. Where the curve intersects saturated-water locus *bc* we have saturated water with a specific volume of 0.020432 cu ft per lb under a pressure of 680.8 psia.

If we heat this saturated water, holding the pressure constant, the temperature remains constant at 500 F and the specific volume of the mixture of *saturated steam* and *water* grows. Continued heating eventually boils off all the water to steam when we arrive at the *saturated vapor* locus *cg* at a specific volume of 0.6749 cu ft per lb.

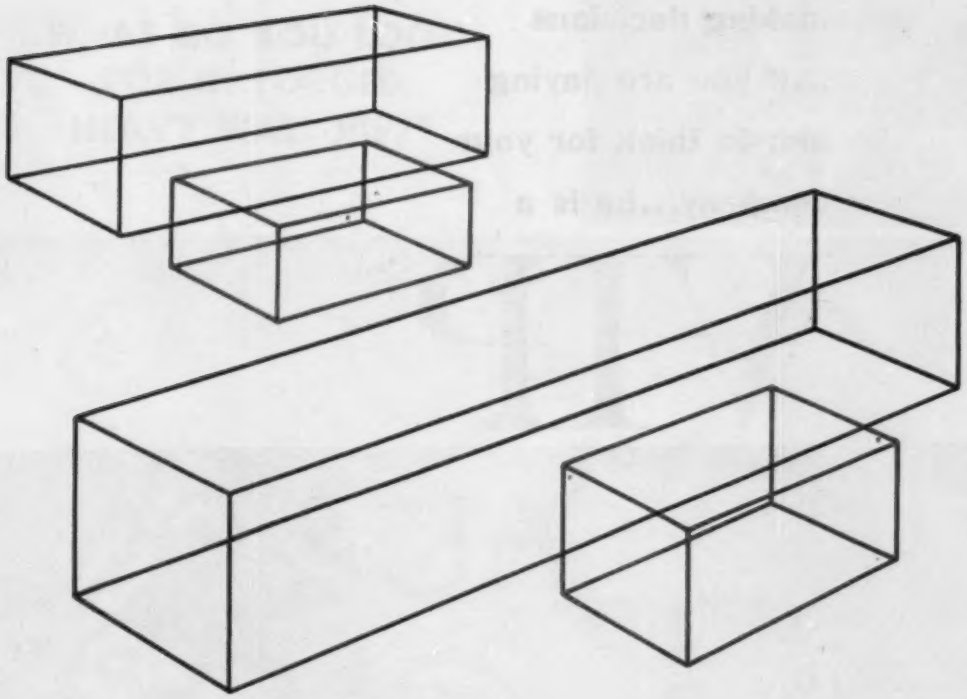
Still holding the pressure constant and continuing heating the saturated steam now raises the temperature to form *superheated steam*. The constant-temperature curves slope downward with increasing specific volume.

Returning for a moment to saturated water at 500 F, let's assume that we cool it, but hold the pressure constant. Its temperature might drop to, say, 32 F and its specific volume would shrink slightly from 0.020432 to 0.020403 cu ft per lb. For most purposes we can assume the subcooled-water region lies on curve *bc* for saturated water. For accurate work at pressures above about 500 psia we may sometimes need to account for changes in volume, where the shrinkage becomes larger on cooling. More on this in a later part.

At temperatures above the critical in Fig. 4 the constant-temperature curves begin to approach the appearance of ideal-gas curves at the higher levels. Notice the distortions in critical-temperature and 800-F curves.

Region between the saturated-water and saturated-steam locus is called the *wet region*, area *a-c-g-e*, extending off the right end of the chart. As state points for steam move from left to right the saturated mixture becomes drier and drier and *quality* increases, or inversely *moisture* decreases. These are figured in percentages of weights of steam to weight of mixture and percentage of weight of water in the mixture.

*Next part covers more about steam charts and tables.*



# The problem of the diminishing ratio

Twenty years ago, when 60 mw was a big generator, there was plenty of room in the foundation for the surface condenser. Even with round shell or heart-shaped units that didn't take full advantage of the rectangular opening, space was no problem.

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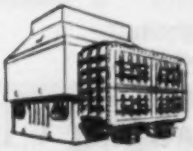

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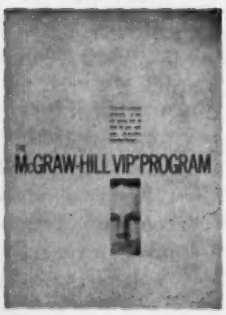


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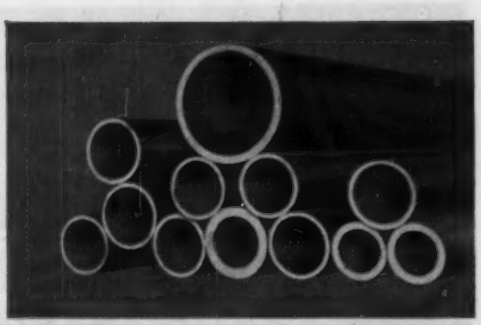

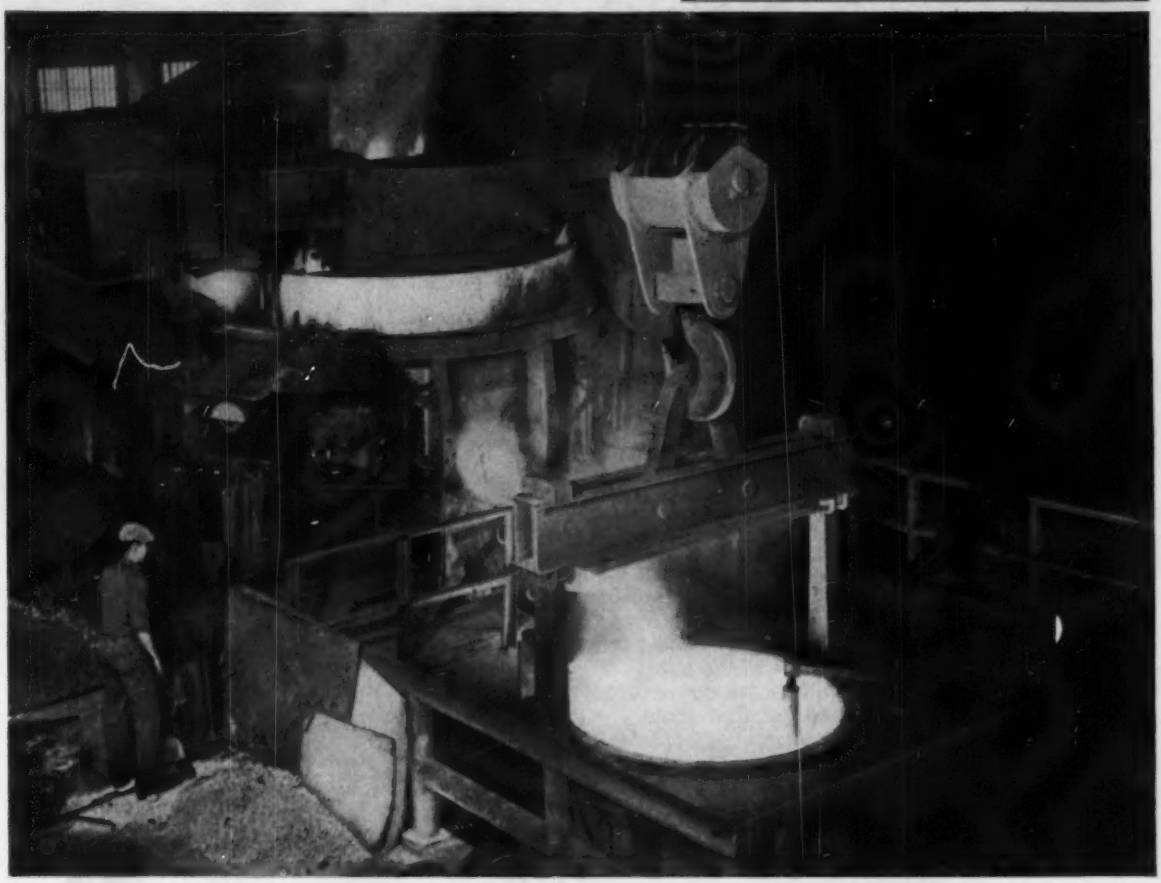

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For more facts circle 303 on Reader Service card, p 133

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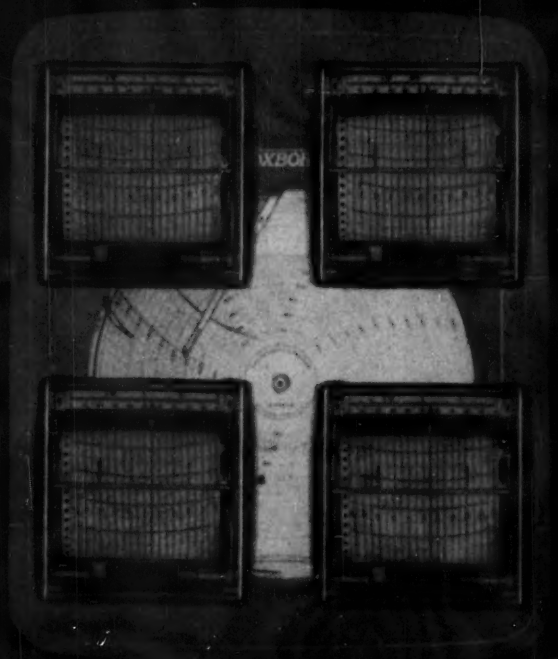

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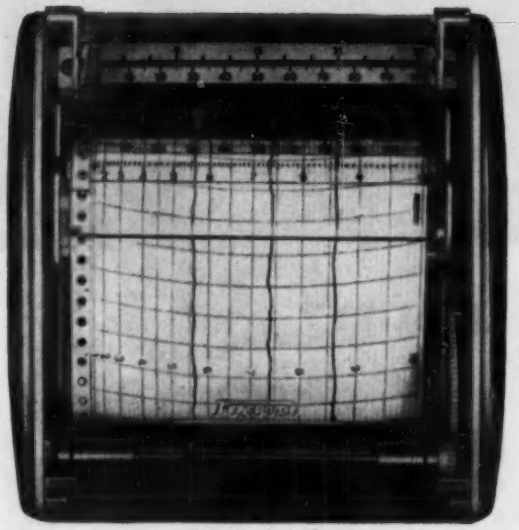

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For more facts circle 305 on Reader Service card, p 133

"When those bright-eyed Chilean dancers kicked up their legs," smirked Marmaduke, "our exciters went into high gear."

# Marmy tightens his belt

O'Houlihan's Machine Shop & Engine Works in Manhattan's Hell's Kitchen was going full blast when I looked in this morning. But I didn't see Marmy there although it was about coffee time. So I climbed the rickety wooden steps to his dingy office.

When I reached the foxy old consultant's place of business it sounded as if all the beachcombers of the Bent Propeller Bar had moved in on him. Opening the bright red door of his office I was greeted by a din of ear-splitting noise and a blast of No. 4 Ringelmann smoke that had me gasping for air. I went into a gentle coughing session for a while; then my eyes stopped watering and I could make out a room full of Marmy's friends, sitting in the dark shadows behind the fog of tobacco smoke. And there was Marmaduke Surfaceblow, all 6 ft 4 in. of him, firmly anchored in his swivel chair with his size-16 canal boats resting on his roll-top desk.

While all the chattering and coffee slurping went on, Marmy sat quietly aloof, totally oblivious to the puny mortals around him. He was gazing dreamily at the ceiling, then revving up his forced-draft blower to keep his stogie going, sending clouds of acrid smoke toward the ceiling.

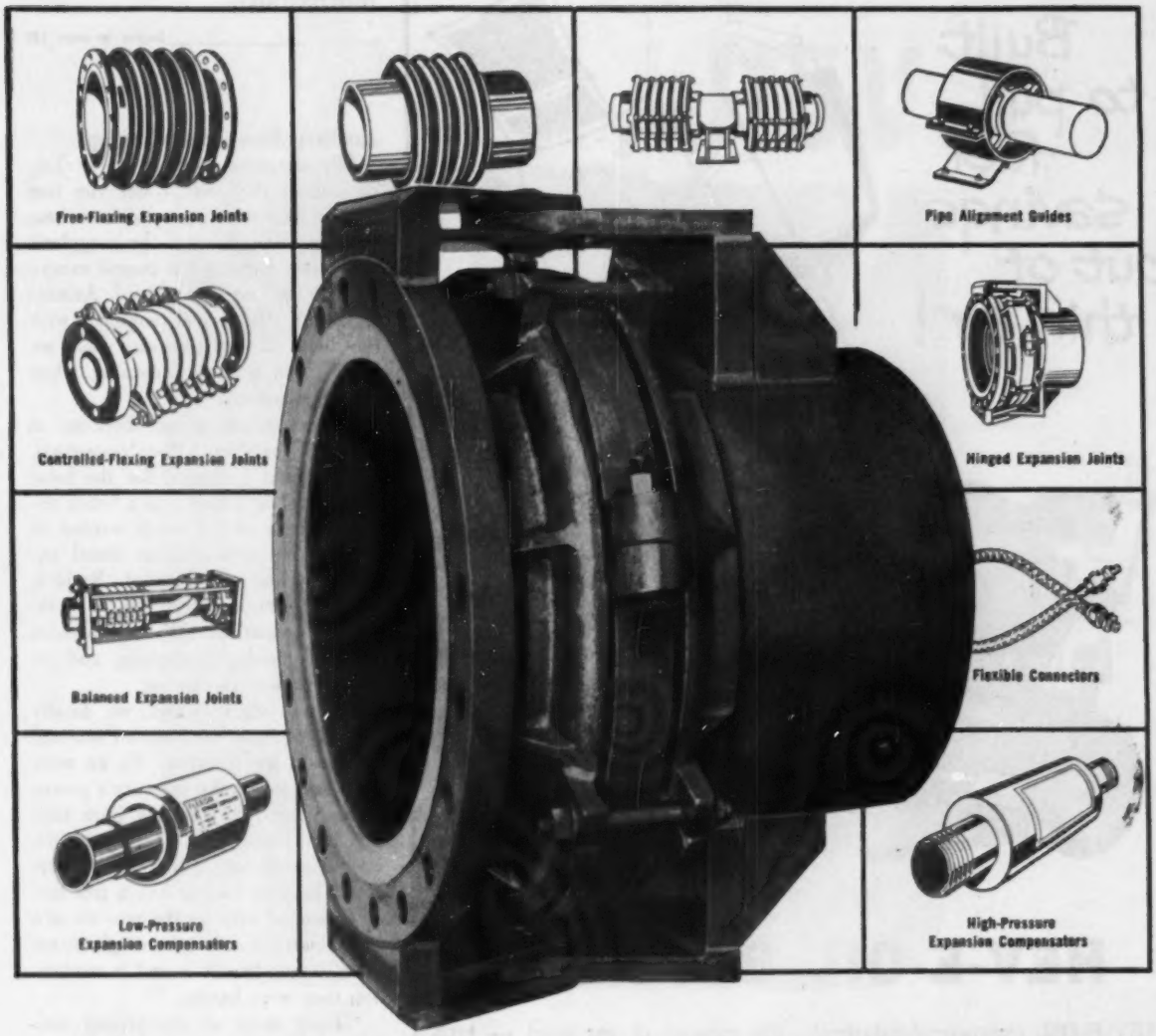
"Now when it comes to speed, take those old China clippers sailing around the horn back in 1849 . . ." cackled one tough-looking marine engineer who had his right arm in a sling. But that's as far as he got.

"BILGEWATER on China clippers," suddenly roared Marmy in his foghorn voice, coming to life with a bang, "I'll tell you shoreside dial twiddlers about the time I tamed a neurotic diesel and all I did was give her screwed-up psyche a lift."

That did it. The Master had spoken. His devout followers quieted down and turned reverent though somewhat bleary eyes towards their hero. Marmy characteristically gave his gray bowler a starboard lift, hooked his thumbs into the armpits of his checkered vest, then blasted away, looking over our heads.

"Back in 1941 I was chief engineer of the motor vessel *Santa Barbara*, running between New York and Valparaiso, Chile. We carried 240 passengers and 6000 tons of cargo. After shoving off from Brooklyn, we'd stop at Havana, then sail through the Panama Canal and head south along the West Coast, making all the important ports in Colombia, Peru and Chile.

"The *Barbara* had two 4000-hp diesel engines driving twin propellers. The engines were 2-cycle 8-cylinder air-injection models, cooled by sea water circulating through their jackets, cylinder heads and pistons. Because they were crosshead type, with top speed of only 105 rpm, they were unusually large for their output. We learned a lot about diesel engines from living day and night, seven days a week, with those main engines and the four 500-hp

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## Marmaduke

Begins on page 180

auxiliary diesels that acted up.

"By the time we tied up in Valparaiso at the end of our run one voyage we were all pooped from heat and overwork. Soon as the gangplank was down I charted a course ashore to look up my old friend Anatole Ogijenko. He was an engineer with the local power company and we usually did a little carousing when we got together.

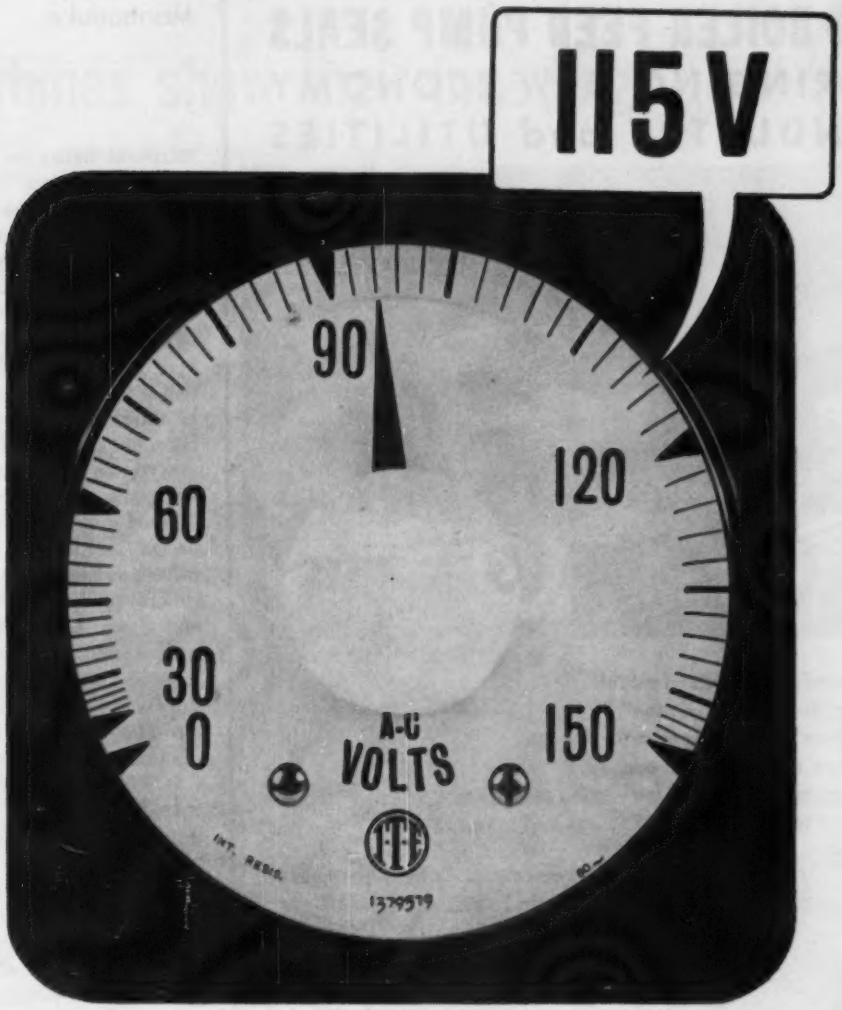
"After ballasting our bottoms at the old Casa Poco-a-Poco restaurant, Anatole and I steered for the local brewery. His friend was a watch engineer there and Anatole wanted to show me a new Belgian diesel engine they had just installed. Besides, we could combine our internal-combustion education with some serious practical product sampling, and all at the brewery's expense.

"It was dark when we finally shoved off from the Poco-a-Poco and arrived at the brewery. So we were surprised to see the brewery's power plant lit up like a luxury liner sailing into home port. Going inside we navigated into a half-dozen characters in what looked like a free-for-all argument over by the new diesel's switchboard. I savvied enough Spanish to know that it wasn't a celebration they were having.

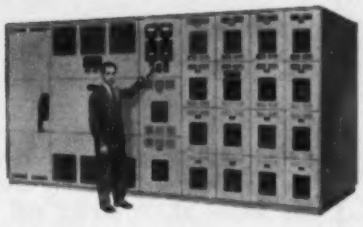
"Doing most of the yelling and arm waving was a fishy-looking guy who turned out to be the owner. On the receiving end was the diesel guarantee engineer. The guarantee man was young . . . looked like this might be one of his first jobs. The owner sounded like a barking sea lion with a Chinese twang. Anatole wised me up that the owner was notorious locally for making life miserable for his bullied coolies.

"'Any jackass can see that your automatic voltage regulator is haywire,' screamed the imitation mogul at the guarantee man. 'I told you a thousand times to look at that tachometer. The engine's speed is right on the nose, the frequency is exactly sixty and she doesn't move a cycle either with or without the load. So all you have to do is repair that voltage regulator—why can't you carry out my suggestions?'

"'How come this inflated beer




# "But I was positive we didn't need another substation!"



**MORAL:** For good voltage regulation and better operating efficiency, put a secondary unit substation in each load area. And for complete information on today's most value-packed line of substations, write for Bulletin 3104-1A, I-T-E Circuit Breaker Company, Dept. SW, 1900 Hamilton Street, Philadelphia 30, Pa.

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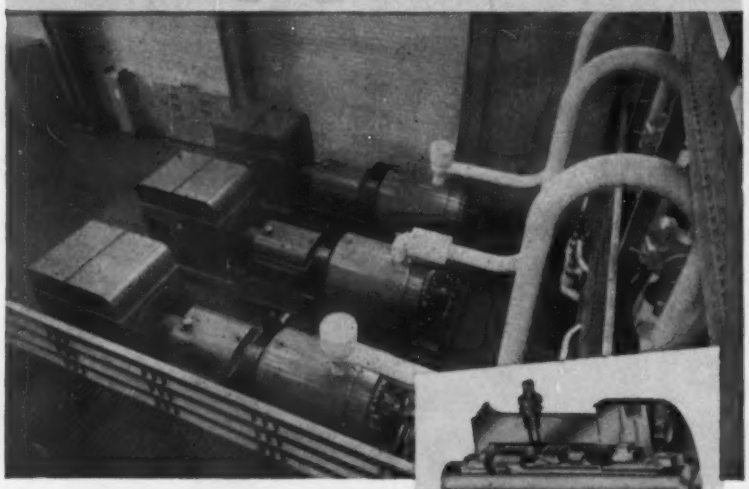

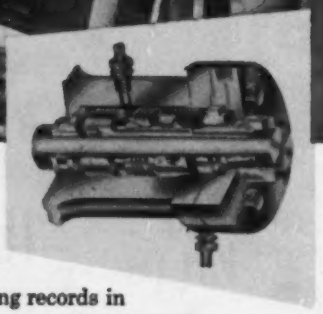

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*Important Economies for Other Hot Water Service, Too!*

If you are operating a power plant, boiler room, industrial or commercial hot water pump system, Bulletin S-230 can help you. Contents include full details on hot water shaft seals that offer the same cost savings as boiler pump feed seals.

Crane Packing Company, 6430 Oakton Street, Morton Grove, Ill., (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

CRANE PACKING COMPANY

## Marmaduke

Begins on page 180

merchant thinks he knows so much about engineering?' I asked Anatole.

"'He keeps broadcasting that he has an electrical engineer's degree from the States,' answered my friend. 'But then,' he continued, 'he inherited this brewery. Now he goes out of his way to pop off about being the best engineer in Valparaiso. And that's the trouble with this plant,' he added. 'There are some good men here, but since he sticks his bow into everything, they let him do the worrying. So there's lots of it.'

"Just then the plant operator connected the load again. That voltmeter pointer went into a crazy shimmy and the voltage bobbed up and down like a fishing-line cork with a nibble. I glanced at the automatic regulator. It was repeating the voltmeter pointer fluctuations, move for move. The operator quickly disconnected the load.

"'Well, what you going to do?' roared the owner, getting pink around the gills. But the guarantee man just stood there with a test instrument in one hand, wiping the sweat from his forehead.

"'I'm not so sure,' he answered finally. 'I checked about everything. At first I also thought the automatic regulator was faulty. When the manual regulator didn't clean things up, I suspected a loose connection on the panel board. But I found none. Then I thought there might be an open circuit in the exciter or maybe a short circuit in the generator windings. I verified the engine speed, but her frequency is steady and the engine runs quietly. Don't know what to check next.'

"'I told you what's wrong a million times and I want this engine on the line in the morning if you have to spend the night here,' raved Simon Legree, waving his booms threateningly again.

"By then I was walking around the engine. But I suddenly dropped my anchor at the exciter and read the nameplate data. The alternator was 210 kva, 500 rpm, 230 to 400 volt and the exciter made 2250 rpm at 5 kw. A guard protected the belt end of the exciter, but something about the way she was running had

# Gas turbines show their breeding

BROWN BOVERI

*By R. L. Steer, Project Engineer, Brown Boveri Corp.*

Brown Boveri gas turbines have the "solid" look of steam turbines. The casings are machined castings. The rotor shafts are large. Bearings and other parts are easily accessible. Each turbine has a single, rugged combustion chamber.

This family resemblance comes naturally. Brown Boveri gas turbines were designed from the start for continuous stationary service . . . in contrast to lightweight units adapted from aircraft engine designs.

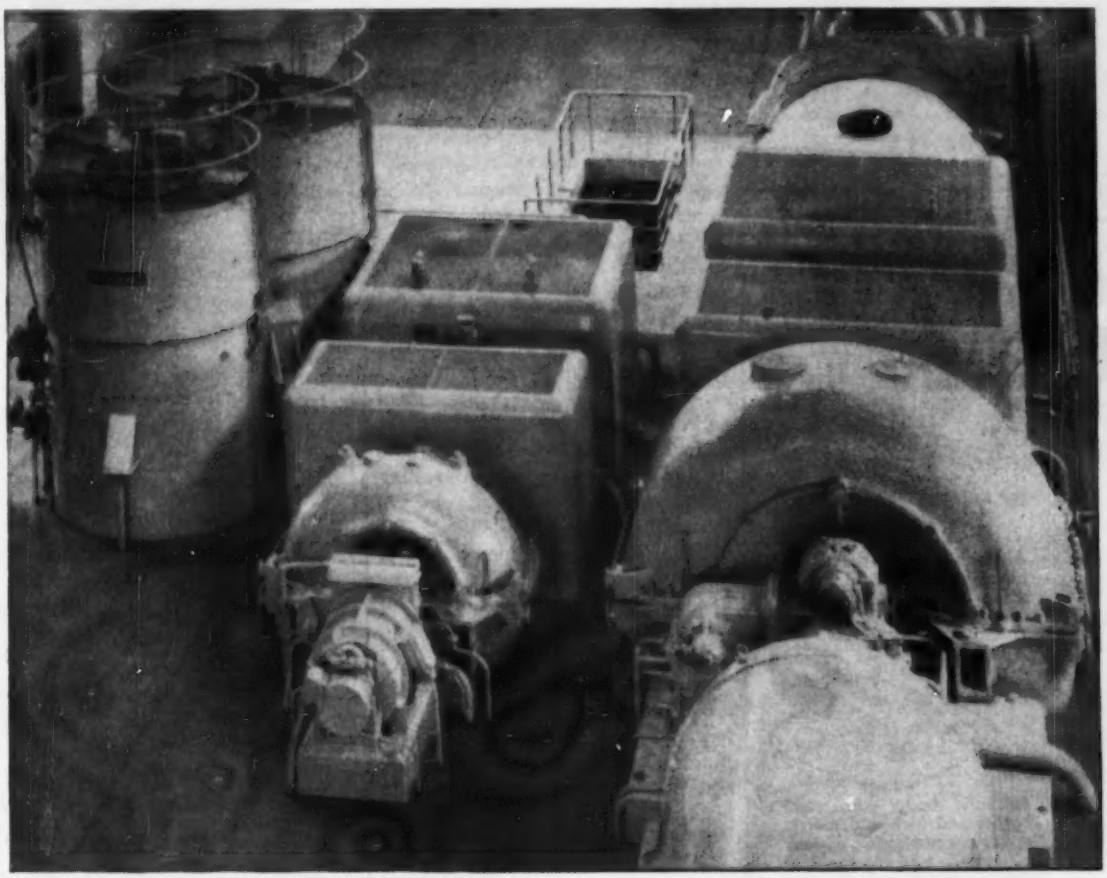
The first large gas turbine-generator, a 4,000 kw unit, was built by Brown Boveri and installed in 1939. It is still operating.

The world's largest gas turbine generating plant at Port Mann, Canada, is unattended! Its four 25mw Brown Boveri units are fully automatic and remote controlled.

Overhaul of two Brown Boveri gas turbine sets at the Pertigalete Cement Works, Venezuela, showed a typical condition: after 15,000 operating hours, components were almost like new. No sign of wear. No repairs or parts changes required.

Scores of Brown Boveri stationary gas turbines totalling over 1,300,000 kw installed capacity are driving generators, compressors and blowers in nearly continuous trouble-free operation—year after year. No other manufacturer can match this experience.

*About Brown Boveri gas turbines: Sizes: 1,200 to 30,000 kw output. Single shaft sets for low initial cost. Double shaft, multi-stage units for lowest cost per kw and higher efficiency. Dual burners, quickly adaptable to gas or liquid fuels. Stationary, semi-mobile or mobile mounts. Completely automatic or remote controls.*



A Brown Boveri two-stage gas turbine. This turbine drives a 25 mw generator part of which is visible at the lower right corner of the photo. Starting time from cold to full load is less than 20 minutes.

**BROWN BOVERI** Brown Boveri Corp., Dept. P4, 19 Rector Street, New York 6, N. Y. Agents in 27 U. S. cities.



For more facts circle 310 on Reader Service card, p 133

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pressures from Vacuum to 250 lbs.
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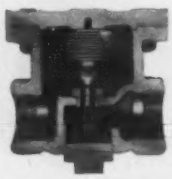
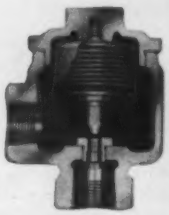


TYPE B-250

pressures from Vacuum to 200 lbs.
Bronze Construction
½", ¾", 1"



TYPE A-200
Freeze-Proof

Simple
Rugged
Versatile
Tight Shut-off

*For additional information contact*

**FRANK D. RIGGIO CO., INC.**
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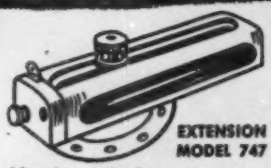
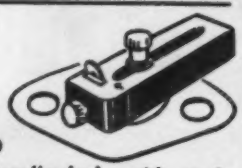


EXTENSION MODEL 747

Aluminum body with steel blades and inch and metric scales. Cuts precision round gaskets any size



HANDY MODEL 750

Phenolic body with steel blades and inch and metric scales . . . cuts round gaskets ¼" to 6", odd shapes and straight pieces any size

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circle 312 on Reader Service card, p 133

## Marmaduke

Begins on page 180

me guessing. The more I watched and listened to that exciter the surer I was of having the right answer.

"The owner was still sounding off so I walked over to him and said as politely as I could, 'The trouble with a low-voltage ruptured fuse like you is that you switch on your loudspeaker before you throw your brain into gear.'

"That did it. Peter the Great turned a lobster red and started working his jaws again, but no sound came out. Then he finally got up enough steam to yell, 'Who the devil are you to talk to me like that?'

" 'I'm chief engineer of the motorship *Santa Barbara*,' I said quietly. 'And I learned something in my seagoing years that hasn't sunk into your cast-iron head with all your schooling. That's to handle people with common courtesy and not to embarrass subordinates, especially if you don't know the answer yourself.' That burned him and his gears started to strip. But I continued.

" 'I'll show you how useless your waterlogged theories are when you can't tell the bow of a diesel engine from her stern. This engine will be running like she's supposed to in exactly fifteen minutes. And all I need is a wrench and a handful of half-in. washers. But since you're such a superior windjammer, I'll have to teach you a lesson in sailing against the wind and charge you $100 for my instruction.'

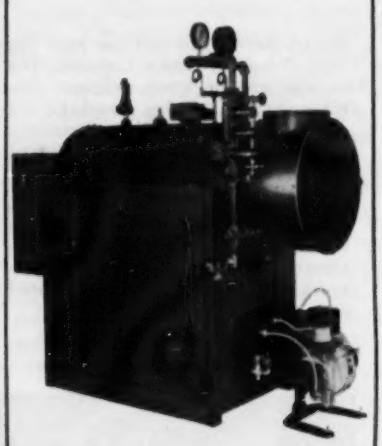
"That sobered him in a hurry. 'I think you're a lot of dunnage,' he finally yelled, 'and to prove it, I'll double that amount if you straighten out this diesel engine. But to show you I'm a sport, I'll give you not fifteen minutes but one hour. Don't forget,' he bragged, 'I'm an electrical engineer. So I know you can't fix that automatic voltage regulator in that time.'

" 'OK, hand over the 200 fish,' I said. 'Because all you have to do is shut down the engine, loosen the exciter's holding-down bolts, and slip enough washers through each bolt to raise the exciter about three-eighths of an inch. Your voltage dances because her three V-belts are oversize and they're slipping!'

continued

**JOHNSON**

**HORIZONTAL STEAM GENERATOR**



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The Johnson Horizontal Steam Generator comes in four sizes to suit your needs, 6½ H.P., 15 H.P., 25 H.P., and 33 H.P. Extra high pressure if desired up to 250 lbs. For complete specifications and details write today for our fully illustrated Bulletin No. 8-C.

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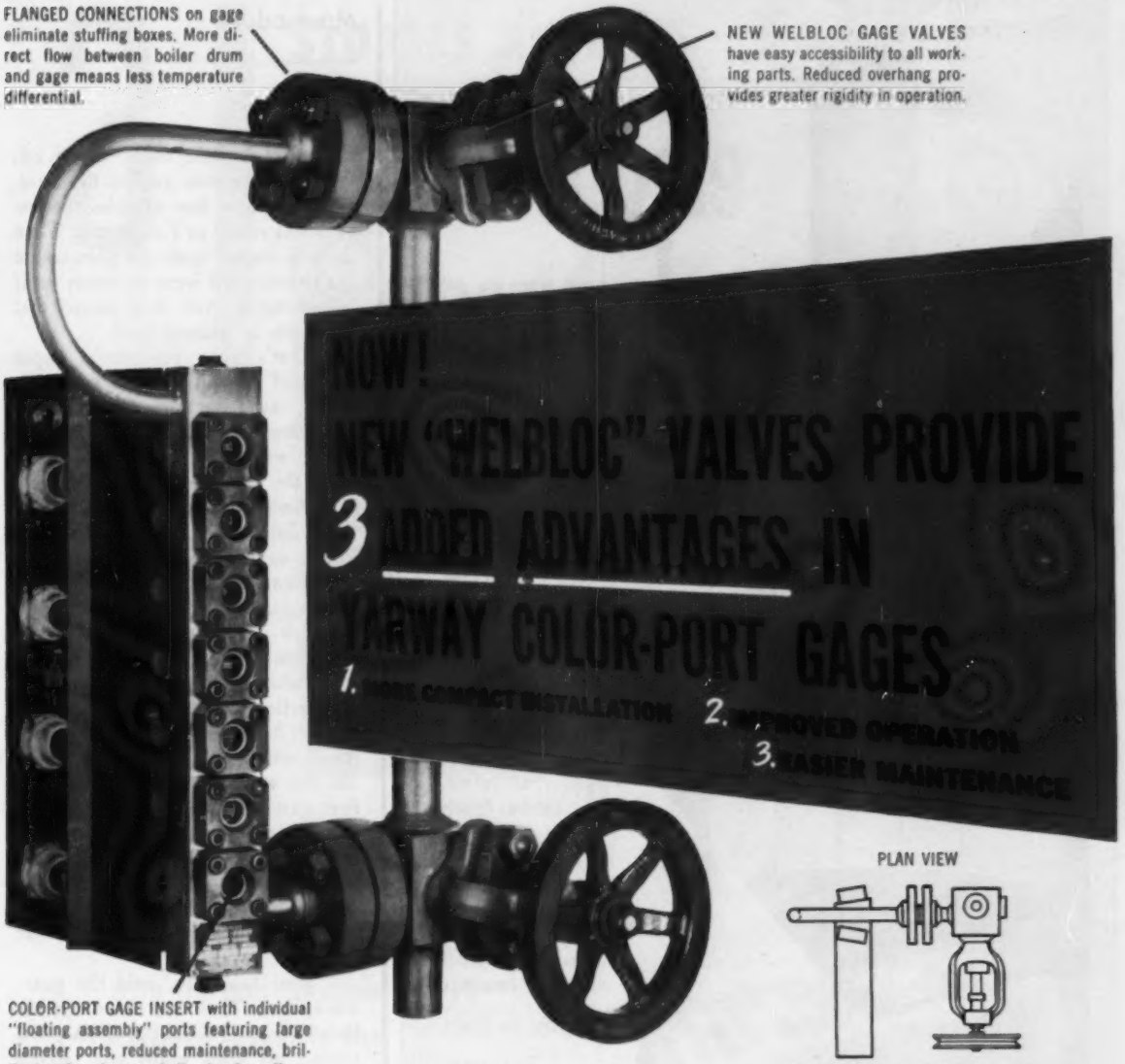
FLANGED CONNECTIONS on gage eliminate stuffing boxes. More direct flow between boiler drum and gage means less temperature differential.

NEW WELBLOC GAGE VALVES have easy accessibility to all working parts. Reduced overhang provides greater rigidity in operation.




COLOR-PORT GAGE INSERT with individual "floating assembly" ports featuring large diameter ports, reduced maintenance, brilliant red and green boiler level readings.

PLAN VIEW



MORE COMPACT DESIGN reduces installation space requirements up to 40%. Note: illuminator may be mounted on either face of gage insert.

Yarway's latest improvement in boiler water level gage design—"WELBLOC" GAGE VALVES—gives you these new advantages:

**SIMPLIFIED INSTALLATION**—Close-coupled design reduces space requirements by 40% in the viewing axis of the gage. Whole unit weighs less, is easier to handle.

**IMPROVED OPERATION**—Greater rigidity when operating handwheels, because of reduced overhang. More direct flow of boiler water to gage, resulting in reduced temperature differential of insert.

**EASIER MAINTENANCE**—Single drain connection serves both gage and circulating tie-bar.

Couple these *3 new advantages* with the well-known standard COLOR-PORT features:

- **brilliant red and green readings**
- **increased operational time**
- **reduced maintenance costs**
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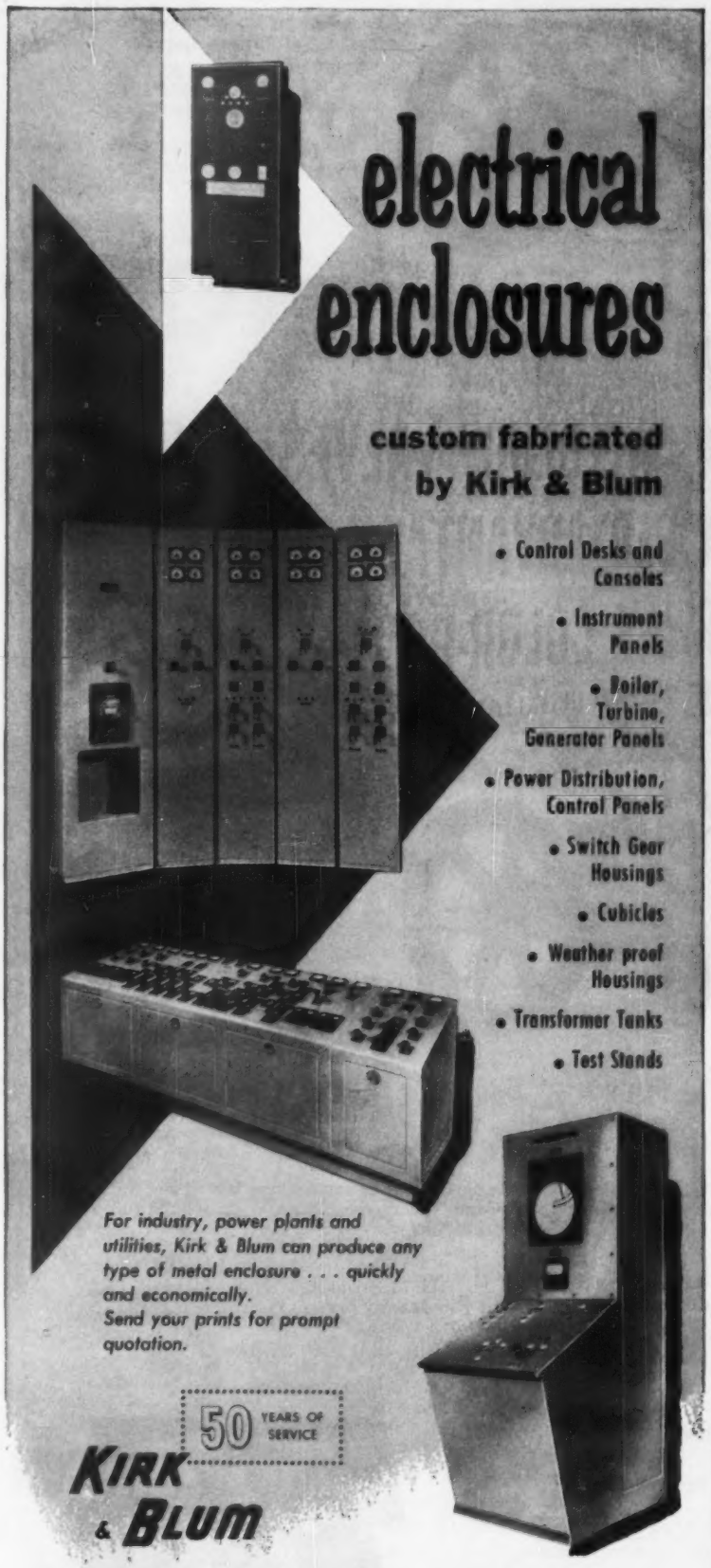
For more facts circle 314 on Reader Service card, p 133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## Marmaduke

Begins on page 180

"Before anyone could sound off, the guarantee man yanked the throttle shut. In a few minutes the exciter was raised as I suggested. When she was started again the pointers on her switchboard were as steady as if lashed there. And they stayed that way with or without load.

"'That's your company's stupid fault and I won't pay this man anything,' raved the stuffed shirt at the guarantee engineer when he saw his engine was OK. 'Your factory supplied the wrong belts—so you pay him. Besides,' he added sarcastically, 'why didn't you find the trouble? You're supposed to be the expert.'

"'Because,' I answered for the young guarantee man, 'you kept flipping his rudder so he couldn't sail a straight course.'

"'Excuse me,' put in the expert, apologetically, 'I'll be happy to pay the two hundred. I'm due in Buenos Aires next week. Your straightening out this engine tonight will save my firm that much money.'

"'No,' I answered, 'you don't owe me a cent. Let's all navigate to that hot night club, the Pocas Palabras, and celebrate. All you have to do is pay our docking charges for the night.'

"'Most happy to,' said the guarantee man. That was too much for the owner; he rushed out of the plant waving his arms wildly and talking to himself.

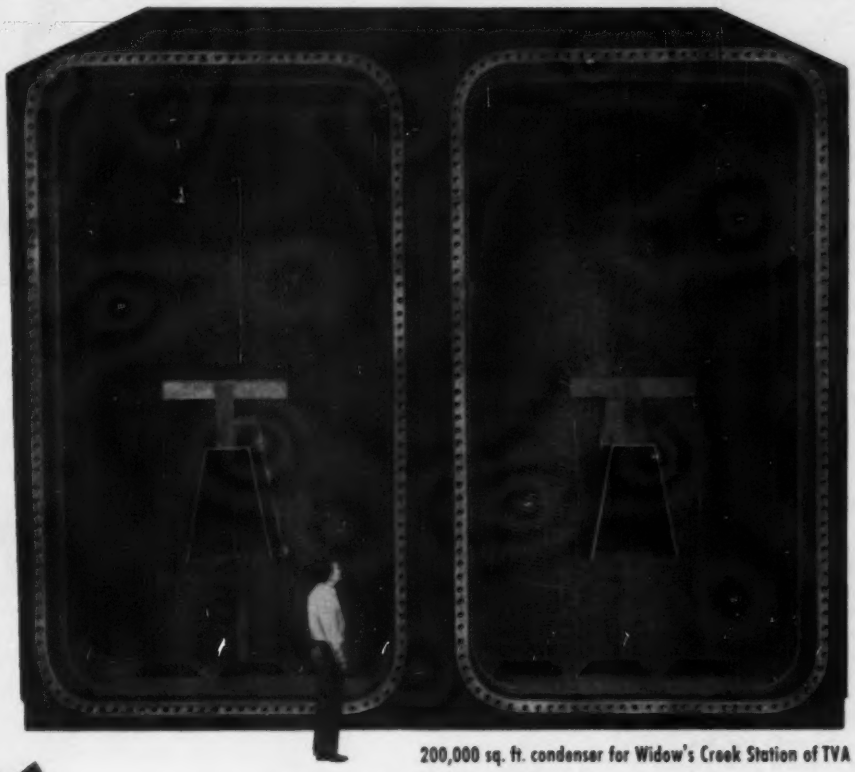
"Anatole, his friend, the guarantee man and I shoved off to the Pocas Palabras. But when those shapely native beauties with the flashing black eyes danced around our table and started kicking up their bare legs to the hot Spanish music, our exciters went into high gear too. And our voltage fluctuated a lot more violently than the diesel engine's had. Only this time tightening our belts didn't steady us." —*SME*

### Reminds of Navy

Marmy's yarns often bring back many humorous incidents that happened while I was in the Navy. And just like his stories, amazing how unusual some of the incidents really were.

E G Evans, *Adak, Alaska*

# 3 STORIES HIGH



200,000 sq. ft. condenser for Widow's Creek Station of TVA

## or BROAD and LOW

**YUBA CONDENSERS—with the most flexible tube bank layout in the industry—designed to fit any plant or space requirements**

This is a three story high, twin-bank condenser—just one of many tube bank layouts possible with Yuba Condensers—most flexible in the industry. Whether you require a giant condenser or a small one, in a single or multiple pass or axial flow design—no matter what the size, type or service conditions, Yuba's flexible design paces the progress in the power industry.

Yuba's twin-bank tube layout, for example, permits turbine exhaust steam to flow unobstructed, with equal distribution throughout the entire tube bank with a free flow to bottom of condenser and into hotwell, where it reheats and deaerates condensate. In Yuba's deaerating condensers, the oxygen in the condensate is guaranteed to be less than 0.005 cc per liter. This design is patented.

For that extra performance, Yuba staggers the tube support plates—reducing harmonics—eliminating vibration. This is just another reason Yuba surface condensers have been installed all over the world in plants of many sizes. For full details, contact Yuba today.

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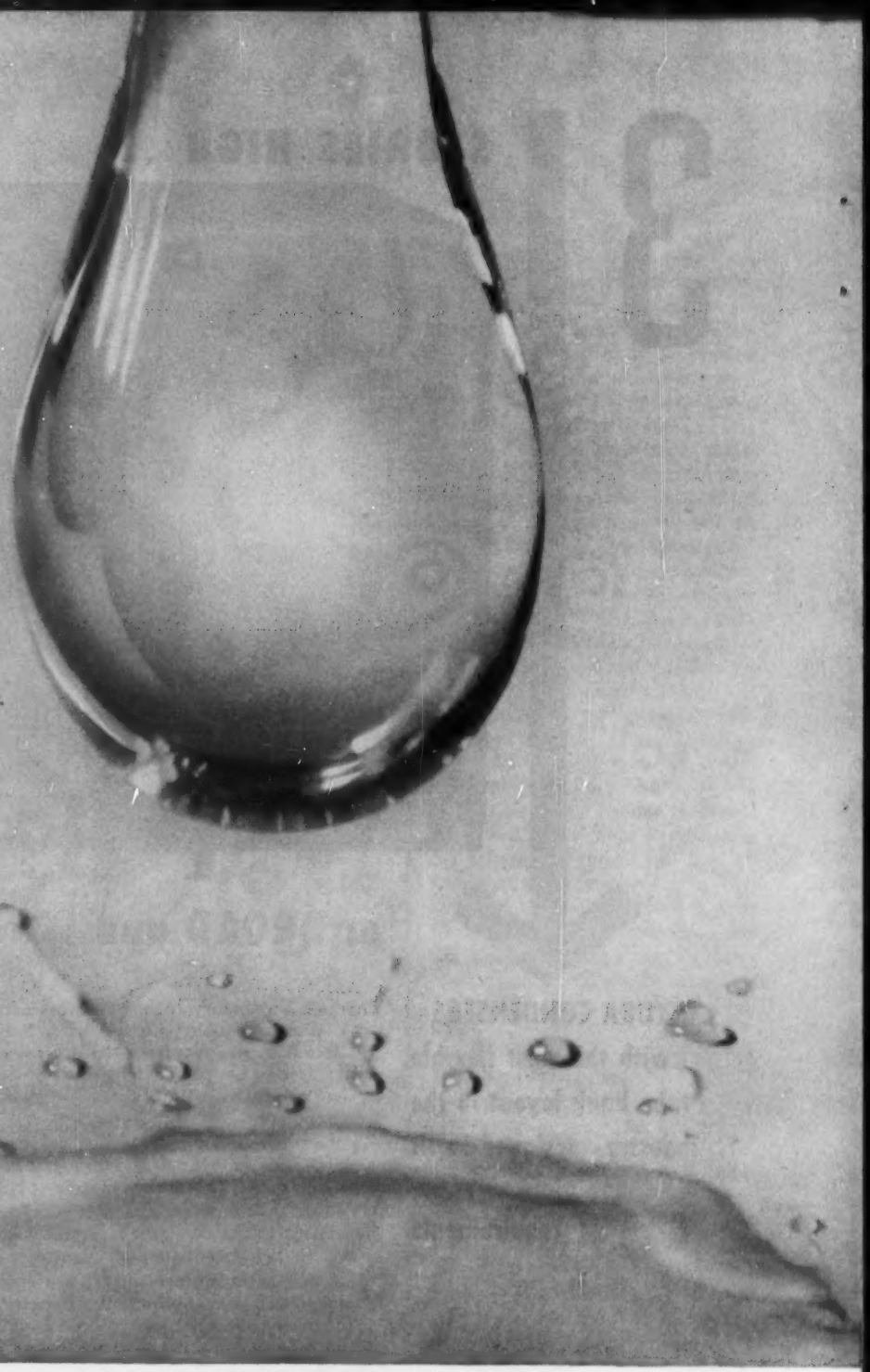
# water



*comes in oceans, rivers, lakes, wells,*
*drops, buckets, pitchers and glasses.*
*it quenches thirsts, cooks food, puts*
*out fires, makes coffee and*
*brushes teeth. it spins mills,*
*runs electro-plants, cools motors*
*and power factories.*
*it spawns fish, sprinkles lawns,*
*floats boats, washes children*
*and grows flowers.*

*it sustains and nurtures.*
*it bends if you give it purpose.*
*it reshapes itself if you give it reason.*
*it is needed, wanted, feared,*
*praised and prayed for.*

*it is at the heart of all life.*
*it is in the arteries of all industry.*
*it is as close to us as skin*
*but as taken for granted as sky.*

*the end of water seems unbelievable.*
*if it is not on the horizon, it is just over it.*
*if it is not within sight,*
*it is just 'round the bend.*
*if it is not in the glass,*
*it is just in the spigot.*

***. . . this is the grand mirage . . .***
***the self-delusion that prevails***
***though the wells run low***
***and the streams go dry***
***and the water slips away.***

*we know water.*
*we know its ways.*
*we've learned its habits.*
*we've pulled it out of swamplands,*
*pushed it over mountains,*
*pumped it into deserts,*
*tunneled it through granite,*
*and rescued it from pollution.*

*above all else,*
*we know the need for it.*
*that is why,*
*for 130 years,*
*we've developed new uses for,*
*powered new factories with,*
*diverted the courses of*
*and jealously stood guard over*
*water.*

# Fairbanks, Morse

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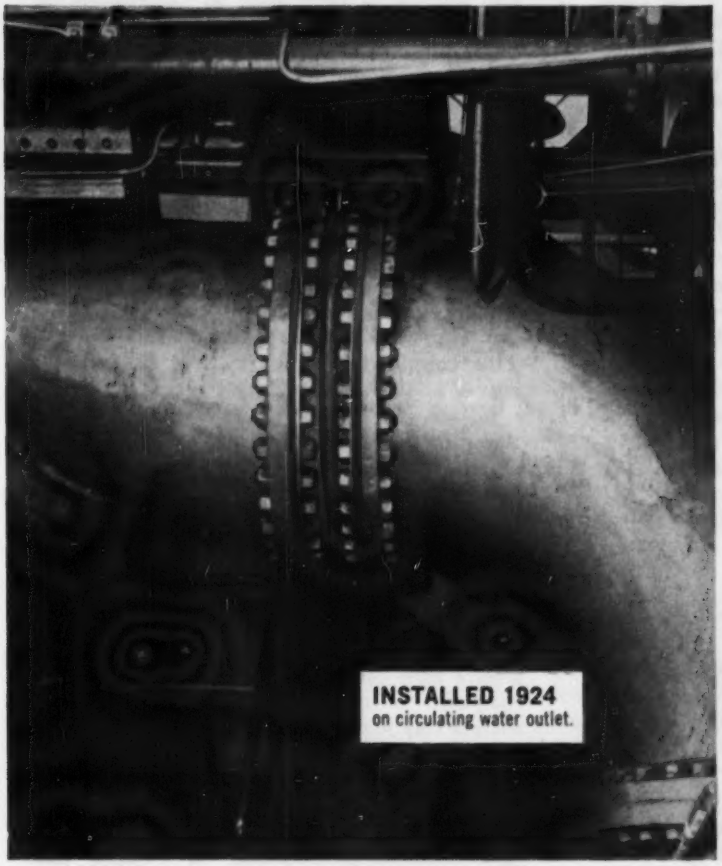
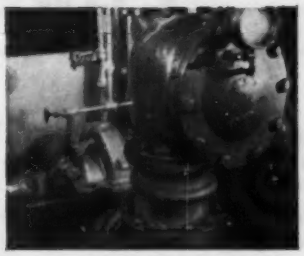
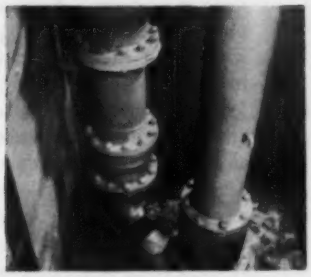


**INSTALLED 1924**
on circulating water outlet.



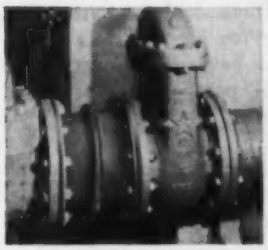
**INSTALLED 1930**
on discharge of harbor water pump.



**INSTALLED 1936**
on discharge of harbor water pump

**INSTALLED 1924**
on circulating water inlet.

**INSTALLED 1941**
on suction end of condensate pump.



**INSTALLED 1941**
on discharge end of booster pump to hydrogen coolers and oil coolers.

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Baltimore Gas and Electric was one of the first utilities to install "U. S." Expansion Joints. These economical, flexible connections are used in pipe lines to take up the stresses due to vibration, expansion and contraction. They prevent the transmission of noise and take care of misalignment, and can be installed on both new and old piping and equipment. Every kind of industry relies on "U. S." Expansion Joints to prolong the life of equipment in pressure or vacuum pipe systems.

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# Powerscope . . . A selective look at

Long Island Lighting Company (New York) plans to install a 100-mw peaking steam unit in its Barrett Station at Island Park. Unit will be running by late summer of 1962, to help shave winter peaks —averaging about 140-hr duration a year. The unit is expected to run about 250 hr per year to carry peaks and also handle load during unit maintenance outages. Average of 50 starts per year are predicted. The 850-psig 900-F 3-in.-Hg unit will be oil fired and have a 14,000-Btu-per-kwhr heat rate. Two operators will run it. Only one feedwater heater will be in the regenerative cycle and summer backpressure will be about 6-in.-Hg abs. Boiler features high furnace heat release, no air heater, pressurized furnace, single f-d fan, no i-d fan and no precipitators. Steam-coil air heaters will be used for winter starts. The unit will cost about $114 per kw; this compares with $173 per kw for a high-efficiency 185-mw unit and $191 per kw for a high-efficiency 115-mw unit. LILCO estimates over $3-million net savings from deferring a 185-mw reheat unit in favor of the peaking low-cost steam-turbine unit.

## Tidal plant defers nuclear plant

***(McGraw-Hill World News)*** **Funds for the $80-million Rance Estuary Tidal Power Plant in Brittany, France will come from a budget switch. Plans are to delay building a 400-mwe natural-uranium gas-cooled graphite-moderated reactor plant called the EDF-4, use the allocation for the tidal plant. Latter will have 34 low-head 10-mw pump-turbine units in a 2400-ft dike. Plant will tap the 34-ft tides for about 570-million kwhr yearly. Construction expected to start in '60 will take about six years to complete.**

A buried 3-mile 6-in.-dia petroleum pipeline has been cleaned using a gas turbine built by the AiResearch Division of the Garrett Corp. Process developed by the Klean Kote Co uses sand suspended in fast-flowing compressed air to clean off mill scale, oil, paraffin, carbonates and rust, and finally polishes the pipe surface. A gas turbine weighing only 365 lb mounted on a trailer produces 2400 cfm of free air. This unit saves about $40,000 investment over previous methods used for petroleum-pipeline cleaning.

## Wildcatting for steam

***(McGraw-Hill World News)*** Magma Power Co of Los Angeles, Calif. will spend up to $150,000 drilling test holes in Hawaii to find geothermal steam. Land leases in the Puna district of the island are near the 1955 and 1960 volcanic eruptions. Success depends on there being an impermeable underground layer that holds the lava-heated steam under pressure. Power would be offered to the Hilo Electric Light & Power Company.

***(McGraw-Hill World News)*** **The U.S.S.R. plans to build "several" 2400-mw thermal plants by 1965. Each standardized plant will have eight 300-mw 3400-psi 1075-F units. Total capacity of these plants will exceed the total capacity installed in U.S.S.R. during past 40 years. Special reinforced prefabricated construction elements will help bring down installed costs to about $152 per kw. This compares with U.S.S.R. 1959 average cost of $345 per kw.**

According to A P Kruegar, MD and J C Beckett, negative ions are beneficial to respiration, but this doesn't mean that negative ions will cure respiratory ailments or relieve a diseased condition. "No evidence suggests that positive ions cause asthma or hay fever; the most that can be concluded is that positive ions . . . may account for some mucosal irritation and may set the stage for infection if other conditions are also present." Electrical engineers must carefully study the use of electrical equipment in confined spaces: positive-ion air charges may impede breathing of men working in those enclosed ionized areas.

## New standby units

**Hydroelectric Commission of Quebec has ordered six 6-mw gas-turbine-generator units from Canadian General Electric for the Gaspé region. The six units will be installed at Les Boules substation for three purposes. They'll handle standby service, act as peaking plant to work with 34-mile underwater transmission cables, serve as synchronous condenser plant for reactive power control.**

## Timid researchers?

Conference of scientists, researchers and educators held at Worcester Polytechnic Institute under auspices of National Science Foundation and 15 professional societies explored ways of speeding technological advances. They recommend: (1) developing educational programs that exercise student's originality and independence of thought (2) bringing talented youth in contact with leading engineers and scientists (3) encouraging more venturesome doctoral research (4) developing institutional policies to abet more creativeness (5) developing closer liaison between college, industrial and governmental research organizations (6)

encouraging activity of creative students and helping them find financial support. To professional societies they recommend: (1) developing programs to draw talented students to meetings (2) encouraging papers looking to future of science and technology (3) developing programs for digesting research knowledge (4) developing more effective interchange of ideas (5) establishing free forums where any member can present his creative work (6) promoting financial support for research (7) encouraging members to stimulate creative development of youth.

***(McGraw-Hill World News)*** **A Russian, B S Blinow, has adapted a Savinius rotor to develop power from river flow without need for dams and flow controls. Several rotors suspended in a flowing river can turn a flexible cable coupled to a generator. The inventor claims that hydro stations using this principle can be built for about $20 per kw capacity and require no heavy construction such as dams and headworks.**

*(McGraw-Hill World News)* Siemens Schukert Werke of Germany has proposed a 1000-mw peakload thermoelectric plant to the United Arab Republic. This would be used with the hydroelectric plant at the Qattara Depression; peaking plant would cost about $357 million and might start erection early in 1963. Peaking plant makes the proposed hydro plant economically feasible.

**Appalachian Power Company of Roanoke, Va. has revised its plans for the proposed Smith Mountain hydro project on the Roanoke River. The plants will now have an installed capacity of 469 mw and cost about $48 million. Concrete-arch upper dam would be about 235-ft high and 815-ft long, creating a reservoir with 1,100,000 acre-ft capacity. Powerhouse would have two turbines driving 150-mw generators, two reversible pump-turbine units each rated 62.5 mw as generators and 101.5 hp as motors. Lower dam, about 18 miles downstream from the upper dam, would be a rockfill about 90-ft high and 930-ft long, creating a reservoir of 110,000 acre-ft. Powerhouse would have two units with 44-mw total capacity in the generators.**

## Mobile diesels ease shortage

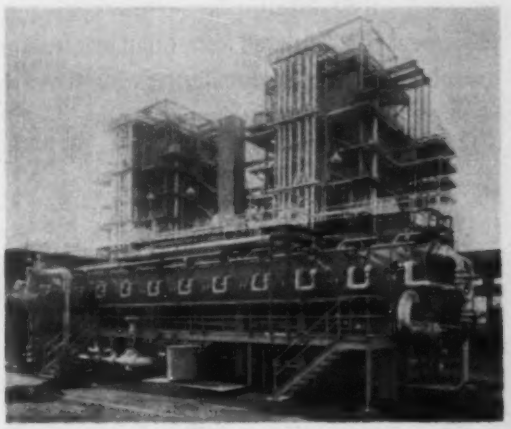
Severe drought in June 1959 caused a power shortage in Belo Horizonte, Minas Gerais, Brazil. Federal and State governments asked American and Foreign Power Co to solve this problem. This was done by installing eleven 1000-kw General Motors Mobile Diesel Cars at one site on the system. Plants were shipped from New Orleans, U.S.A. to Rio de Janeiro. There they were fitted with 1.6-meter trucks for hauling by rail to Belo Horizonte. All eleven units were on the line in 55 days from initial request. During normal water flows the diesels are used for peaking and emergency service.

## White-collar portrait

**The National Office Management Association, making an office-customs survey, found: the male office worker is expected to dress in good taste, except in warm weather when he may wear a sport shirt. He smokes at will, gets snacks from a dispensing machine during two coffee breaks per day, places personal telephone calls at company expense, receives personal calls any time. Each winter he has a company Christmas party and in the summer an office picnic, both at company expense. He receives personal mail at the office unopened.**

## Experimental sea-water evaporator

Southern California Edison Company now has the first general-purpose sea-water-conversion plant running at its Mandalay Beach Plant near Oxnard, Calif. Demonstration plant, supplied by Cleaver-Brooks Special Products, Inc, will undergo a 3-year research program. The 100,000-gal-daily plant cost over $250,000 and runs on the multistage flash-evaporation principle. The 26-stage evaporator injects 170-F sea water into its first stage, heating steam being extracted from the station turbines. The main evaporator is 70-ft long and has more than eight miles of aluminum-brass tubing. This evaporator does not have capacity to supply the total fresh water needs of the Mandalay Beach Plant.



# BUELL CAME UP FAST ON THE OUTSIDE!

**In fly ash collection** the specification of electric precipitators is... increasingly... "Buell". The 1959 central station design survey published by POWER magazine in October, 1959 shows that Buell installed 8 out of 22 precipitators. And that high proportion was not surpassed even by the longest-established manufacturer in the field! ■ Why this fast-growing demand for Buell electric precipitators? There are many reasons. Unique design features minimize maintenance and provide exceptionally high efficiencies. In 10 years of selling Buell SF Electric Precipitators, the number of spare and replacement parts ordered from Buell has amounted to less than 2% of the total sales! You seldom replace Buell's exclusive 'Spiralectrodes,' because the rigid fastening makes sure they won't break. Their precise construction of strong-heavy stainless steel prevents rust and corrosion. ■ See for yourself some of the reasons why men in many industries are specifying Buell SF Electric Precipitators. Send now for details. The Buell Engineering Company, Inc., Dept. 50-D, 123 William St., New York 38, N.Y. Northern Blower Division, 6404 Barberton Ave., Cleveland, Ohio. (Subsidiary: Ambuco Ltd., London, England.)

buell Norblo


# Reports
## from the field

### Converter delivers 6000 kw from 312 silicon cells

Ac-to-dc silicon-rectifier conversion unit, a 3-year joint development by Westinghouse Electric Corporation and Aluminum Company of America, is said to have greater current-carrying capacity and higher efficiency than any previous large silicon rectifying equipment. Rated 10,000 amp at 600 v, unit uses high-efficiency rectifying devices eliminating the need for elaborate apparatus to discharge heat generated by ac-to-dc conversion. Number of devices needed to build unit was correspondingly reduced. Maker was able to contain equipment in aluminum cubicle measuring 9x5x10 ft.

The 10,000-amp converter has been installed at Alcoa's Badin, N. C. plant where it is supplying power for the aluminum-smelting process.

### Solar-turbine blueprint completed

**Vienna, Austria** (*McGraw-Hill World News*)—World's first solar turbine has been designed by a Soviet engineer, Russians claim. Its operation depends on a special alloy rotor distinguished by a low curie point. Made of a series of concentric hoops, rotor rim is connected to shaft by means of spokes. Poles of a permanent magnet are applied to rotor.

When rotor's temperature equals ambient temperature it is immobile because of equal attraction of magnets on both sides which balance it.

continued



For more facts circle 319 on Reader Service card, p 133

circle 320 on Reader Service card, p 133 ➤

Swagelok

# GOOP®

## prevents galling
## prevents seizing
## protects valuable equipment

GOOP is the amazing new compound for ending the costly galling, seizing and resultant destruction of threaded parts.

The line includes three separate products: Blue GOOP, Silver GOOP and High Purity GOOP.

**Silver Goop®** is formulated to prevent seizing and galling of threaded parts, regardless of applied load, at temperatures up to 2100° F. It reduces take-up torque on threaded parts. Will not drip off red-hot surfaces nor give off poisonous metal or oxide fumes at high temperatures. Resists water washout.

**Blue Goop®** is an anti-seize and sealing compound for use on titanium, stainless steel, steel, aluminum and high temperature alloys. Withstands temperatures up to 400° F. Impervious to water washout, most acids and all petroleum solvents.

**High Purity Goop®** is an anti-seize and sealing compound for titanium, stainless steel, steel, aluminum and high temperature alloys. Withstands temperatures up to 400° F. Impervious to moisture, high voltage and cyclic thermal stress. Recommended for use wherever prevention of product contamination is an important factor.

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**884 East 140th Street**
**Cleveland 10, Ohio**
*Crawford Fittings (Canada) Ltd., Niagara Falls, Ontario, Canada*

# the V-notch

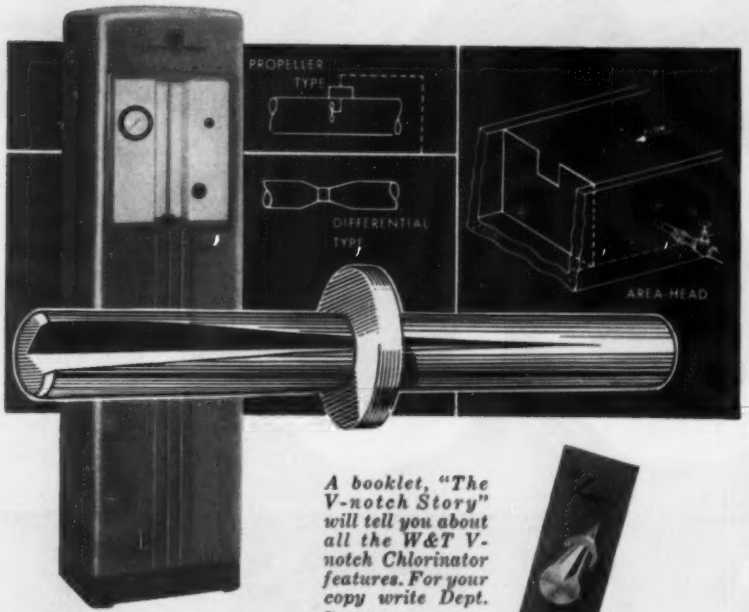
*ready and waiting for your signal*

Lots of jobs are done better automatically. Changing chlorine feed rate is now one of them. With the V-notch...the straight line metering action of the plug through the ring makes automation simple.

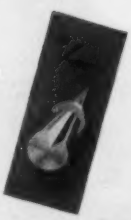
Merely by adding, not adapting, a W&T V-notch Chlorinator can give you any degree of automatic control you want—step rate, start-stop, program, proportional, even residual control.

With a V-notch Chlorinator any signal from any primary metering device can control chlorine feed. So anyone can afford automation.

And, of course, the right plastics make the whole chlorinator chlorine-proof.




*A booklet, "The V-notch Story" will tell you about all the W&T V-notch Chlorinator features. For your copy write Dept. S-136.76.*



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WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY


## Reports from the field

Begins on page 194

When small segment of rim is heated above curie point, balance is upset and heated segment of rim is no longer attracted to magnet. If one side of rim is continually heated by the sun, rotor starts revolving. This solar turbine could be used in conquest of the moon.

### Molten-metal action on pumps is under study

Critical nuclear-pump design question is the action of liquid metals such as mercury, sodium and lead-bismuth on the pumps that must handle them. Prof F G Hammitt of the University of Michigan is searching for part of the answer.

Hammit is investigating erosion and cavitation in pumping. Where liquid metals are used, he says, an unexplored chemical reaction accompanies cavitation. Another unknown factor is quantity of erosion to be expected. If these pump-performance limits are better understood and defined, pumps can be made smaller and cheaper.

### McGraw-Hill book pirated in Red China

*Pump Questions and Answers*, written by Worthington Corporation's Igor Karassik and other Worthington engineers, arrived recently from Red China much to the amazement of its authors. It was printed entirely in English and bore the stamp of a Red Chinese publisher.

The book had been published by McGraw-Hill in 1949. Chinese edition is an exact duplicate of the original edition—each page was photocopied. Only change is that in place of the McGraw-Hill stamp the Chinese publisher substituted his own. A list of other books published by the Chinese publisher was included in the Chinese version.

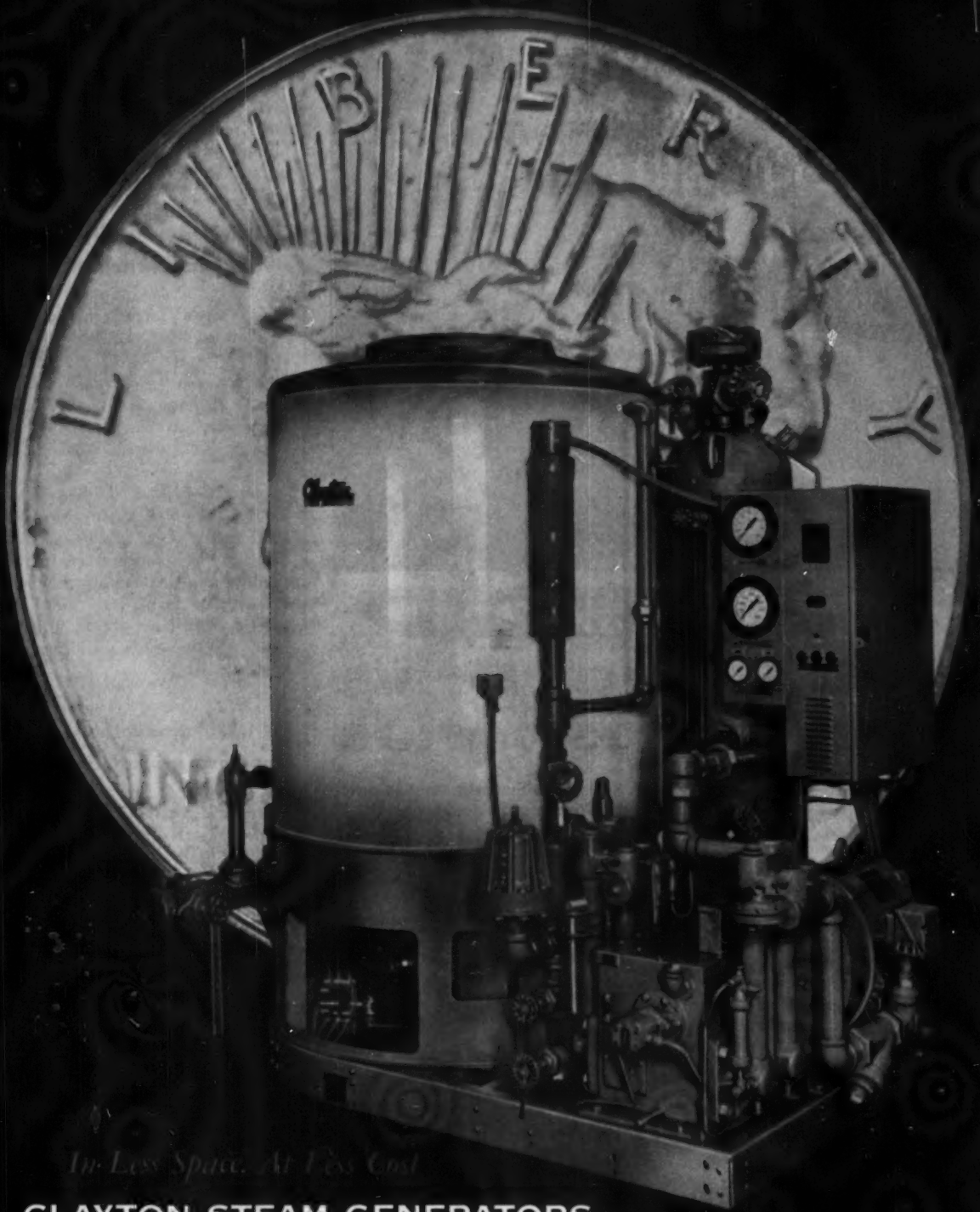
For years both Russia and China have been pirating books authored in the free world, ignoring copyrights and authors' wishes. Recently, how-



For more facts circle 321 on Reader Service card, p 133

circle 322 on Reader Service card, p 133 ►

STEAM THE MODERN WAY




*In Less Space, At Less Cost*

## CLAYTON STEAM GENERATORS...

SAVE SPACE AND INSTALLATION COSTS—Only a fraction the size and weight of ordinary boilers. Models from 16½ to 175 HP. All sizes 65 to 195 psi. Larger sizes 15-295 psi.

SAVE ON STEAM—You pay only for the steam you use. Steam in 5 minutes or less from cold start—no standby loss.

SAVE ON OPERATING COSTS—Cut fuel costs up to 50%, save labor, maintenance and time.

Write today for more complete information.

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Compact RIDGID
300 Power Drive
with Accessories

**Portable, Fast and Easy-to-Use, Low Cost. 1/8" to 2" Capacity; Power for up to 12" Geared Tools**

Here's such an amazing power package that you'll have to try it to believe it. It's built around the compact, rugged RIDGID 300 Power Drive with famous RIDGID Speed Chuck that grips tight—forward or reverse, yet sets and releases easily by hand. Cam-action rear centering device holds even long lengths centered for perfect threads every time. Sturdy No. 1206 Stand folds for easy carrying . . . is extra rigid when in use.

RIDGID No. 310 Carriage, made of strong aluminum alloy, slides smoothly on drive support arms . . . holds die head and cutter ready for instant use. Snugs up tight to chuck for close threading and cut-off.

RIDGID 535 Quick-Opening Die Head, shown here, threads ½" to 2" pipe with just 2 sets of dies . . . adjusts to size right in machine . . . no fumbling for right size threader . . . no slow back-off. All other RIDGID Machine Pipe and Bolt Die Heads can be used. Add a RIDGID No. 19 Nipple Chuck, and you can thread close nipples.

RIDGID 360 full-floating Cutter has slide action that adjusts to all pipe irregularities . . . wide rolls for straight cuts at machine speed. Capacity: ¼" to 2" pipe and conduit—⅞" rod. E-1032 wheel for 1" rod available.

**See and try this time-and-work-saving RIDGID 300 group at your Supply House!**

RIDGID
The Ridge Tool Company, Elyria, Ohio, U.S.A.


## Reports from the field

Begins on page 194

ever, consternation was caused in the Kremlin when China became a pirate's pirate and reprinted Russian texts after stealing them.

### Hydro station orders 141 80,000-amp switches

Hemisphere's largest hydroelectric generating plant, Lewiston Station on the Niagara River, will use 141 high-momentary switches, rated 115 or 230 kv, to route and sectionalize h-v power. Switches are being supplied by I-T-E Circuit Breaker Company.

Lewiston Plant will feed power to the Niagara Switchyard, furnishing 1950 mw of a 2190-mw total. Switches have momentary-current ratings of 80,000 amp, continuous-current ratings of 1600 amp. The 115-kv units have 550-kv BIL ratings; 230-kv switches will be rated at 900-kv BIL.

### Soviets claim synthetic transformer insulation

**Vienna, Austria** *(McGraw-Hill World News)*—Synthetic resins on metakryl basis were used for the first time as low-cost insulation layers for single-phase tension-measuring transformer construction in a Moscow factory. Insulation ranges are 6, 10 and 15 kw.

When solid, MBK compound has high electrical resistance combined with sufficient mechanical properties and high heat resistance — 125 to 150 C. Solidification process takes place under 80- to 120-C heat or in coil condition with special catalysts.

### Site chosen for Canada's 2nd nuclear-research center

Whiteshell Nuclear Research Establishment, Canada's second nuclear-research center, will be located on 11,000 acres of land 60 miles northeast of Winnipeg, Manitoba. According to Atomic Energy of Canada Ltd, the new center will start as a small

# world in a hurry

*What is Hawker Siddeley doing here?*

In a world excited by its own technical mastery, the problem has become not "If only . . ." but "How soon?". How fast can we produce the thousand things that will allow all the world's people to live in happiness and dignity? How soon replace the last oxen with the diesel-driven harvester, how soon give a giant's strength to the work of men's hands with electric power plants? In the race for a better life Brush Electrical has an active role. ☐ Think of almost any kind of power equipment and you'll find that Brush has a part in it. Power to speed ships and trains, power for factories and townships or power for an entire electric generating plant . . . this is the work of Brush Electrical, one of the companies of the world-wide Hawker Siddeley Group. Whenever, wherever you wonder "Who can do this?" it will pay you to tap the enormous resources of the Group for information. ☐ There is a representative in your part of the world who can speak for the group — call him. **HAWKER SIDDELEY GROUP**

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For more facts circle 324 on Reader Service card, p 133

**Engineered Features of Super-Silvertop Steam Traps Assure Trouble-Free Operation**

For trouble-free steam trap operations, with engineered, maintenance reducing features, install Super-Silvertops. First, there are no narrow cored passages to become clogged or to limit the flow. Second, a patented center tube guide arrangement of the bucket assures positive seating—keeps all parts in proper alignment. Third, valves and seats are made of Anderloy, an alloy developed to resist corrosive action. And fourth, reverse flow feature keeps the bucket stationary even under heavy loads, cleans trap of sediment and dirt. Send coupon for Bulletin #26, giving sizing details of these remarkable trouble-free traps.

**A TRAP FOR EVERY PURPOSE**

**THE V. D. ANDERSON COMPANY**
*division of International Basic Economy Corporation*
**1961 West 96th Street • Cleveland 2, Ohio**

Please send without obligation your Bulletin #26 giving sizing details.

Name_____ Title_____
Company_____
Address_____
City_____ Zone_____ State_____

**ANDERSON SUPER•SILVERTOPS**




Begins on page 194

unit but will expand as nuclear research expands and may reach a size comparable to that of the Chalk River Plant. Some work on the Whiteshell site will begin next summer, but building of a major research facility is not expected to start before 1961.

## Columbia U will offer nuclear-engineering degree

Beginning with the academic year 1960-61 starting this September, Columbia University School of Engineering will offer a new degree in nuclear engineering. This degree will be for professional engineers who wish to practice nuclear engineering but who do not need a doctorate, according to D Barr, assistant to the dean of the Faculty of Engineering.

The NE degree will be more advanced than a master of science degree but less rigorous than a doctorate, said Barr. Degree will require 30 points beyond the MS degree and 60 beyond a BS if the candidate did not previously require a master of science degree. Degree will not require a thesis if one was submitted for an MS but it will require comprehensive examinations.

## CERN receives $500,000 grant

The European Organization for Nuclear Research (CERN) has received a grant amounting to $500,000 from the Ford Foundation. Covering a period of four years, the grant will enable CERN to invite expert physicists from nonmember states to Geneva to work in organization laboratories.

Facilities now available comprise two big particle accelerators, a 600-million electron volt synchro-cyclotron and a 28,000-million electronvolt proton synchrotron—latter is said to be the most powerful atom smasher in the world.

A previous grant from the Ford Foundation consisting of $400,000 was contributed in 1956 to cover similar expenses during four years.

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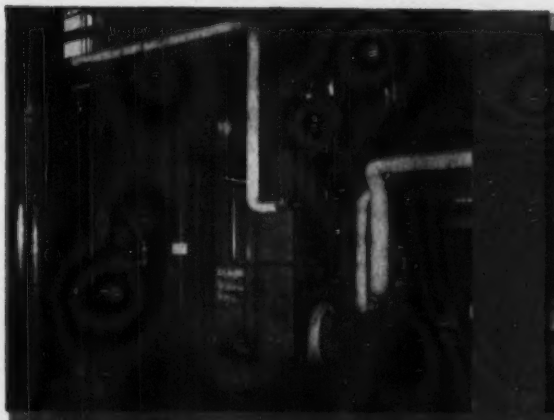
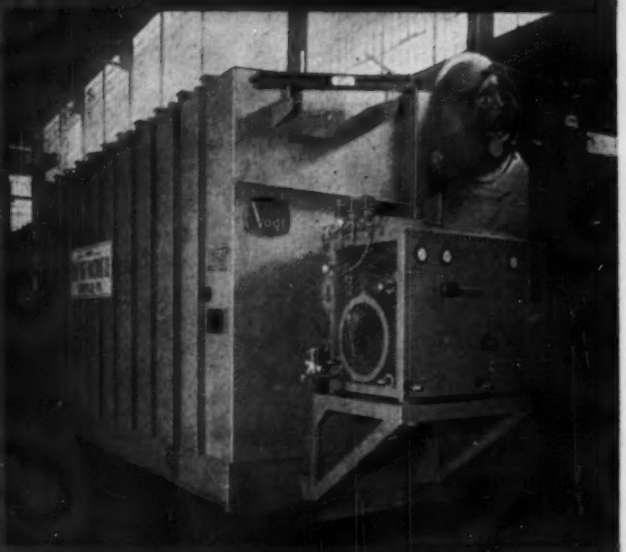


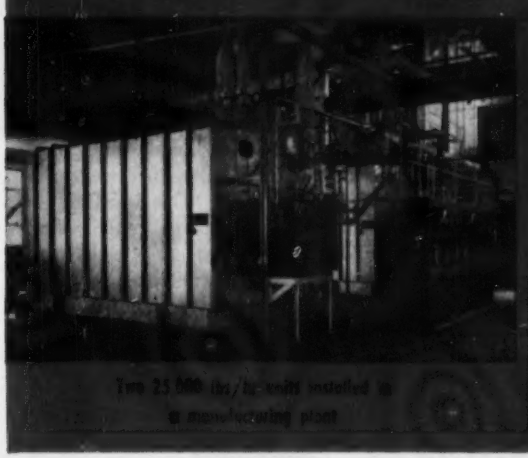
# More Steam per dollar of investment with Vogt

## PACKAGE WATER TUBE BOILERS

Completely shop fabricated, with burners, controls and accessories installed before shipment.

Placed on a suitable foundation, only fuel, water, breeching and steam connections need to be made to place unit in operation. Vogt Package boilers are available in oil and/or gas fired types in standard pressures of 175, 250 and 375 pounds per square inch gage.





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**HENRY VOGT MACHINE CO.**
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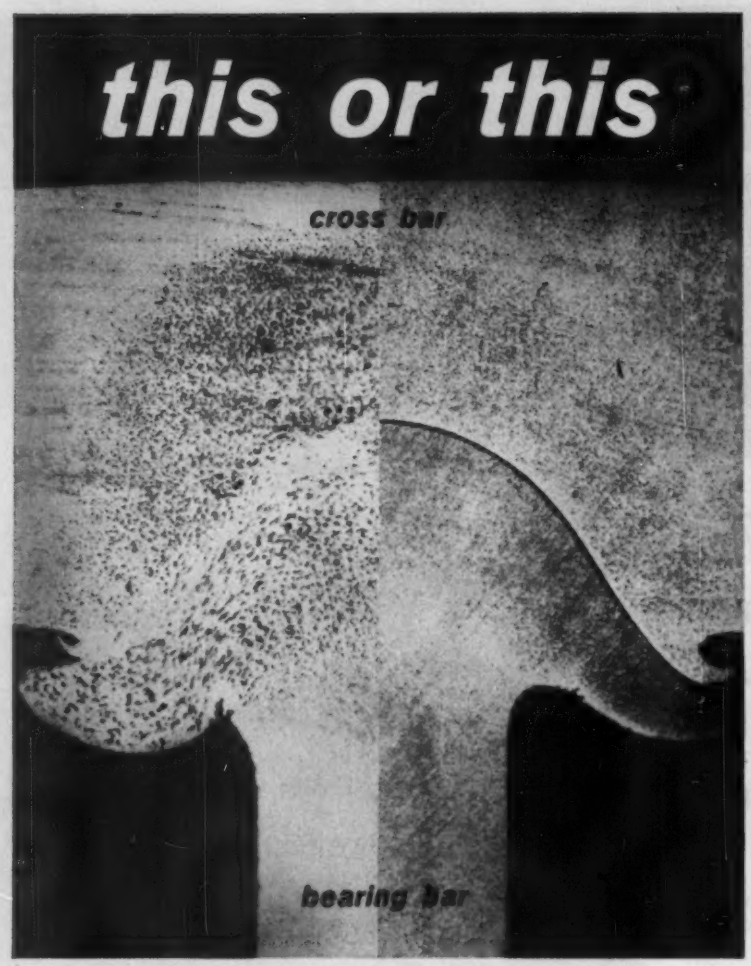



**This is Dravo Tru-Weld Grating.** In this cross section of a cross bar-bearing bar weld, the metal has fused together. There are no gaps to admit moisture or weaken the joint. It cannot come apart.

**Here fusion of metals is incomplete.** There is a noticeable gap between bearing bar and cross bar, an open invitation to internal corrosion which can weaken the joint and add to maintenance costs.

## which weld for your grating?

Tru-Weld grating is stronger because it is *made* that way. Its added strength comes from a manufacturing process that completely fuses the metal at cross bar-bearing bar joints and holds the bars to exact spacing. The result is grating that stands up under excessive vibration, heavy traffic or in areas where corrosive fumes and moisture are a problem. And Dravo Tru-Weld grating *costs no more.*

Complete estimating, layout and fabricating services are available. Immediate delivery from stocks maintained at nearby Joseph T. Ryerson Service Centers will help you meet exacting construction schedules.

For more information on this new, stronger grating, call the Dravo representative in your area, or write DRAVO CORPORATION, PITTSBURGH 25, PA.

**DRAVO**
CORPORATION


## Reports from the field

Begins on page 194

### Thinking machine may outdo its human creator

The man in the street often assumes that because machines do not possess any degree of originality, a man-made machine must remain continually subject to man. Nothing can come out of a machine that has not gone into it, and its operation is at at any time open to human interference. Dr Norber Wiener, Institute Professor, Massachusetts Institute of Technology, thinks differently on this subject. In a talk at a symposium of the American Association for the Advancement of Science reported in *Product Engineering*, Dr Wiener expressed the opinion that machines can and do transcend the limitations of their designers and that in doing so they may be both effective and dangerous.

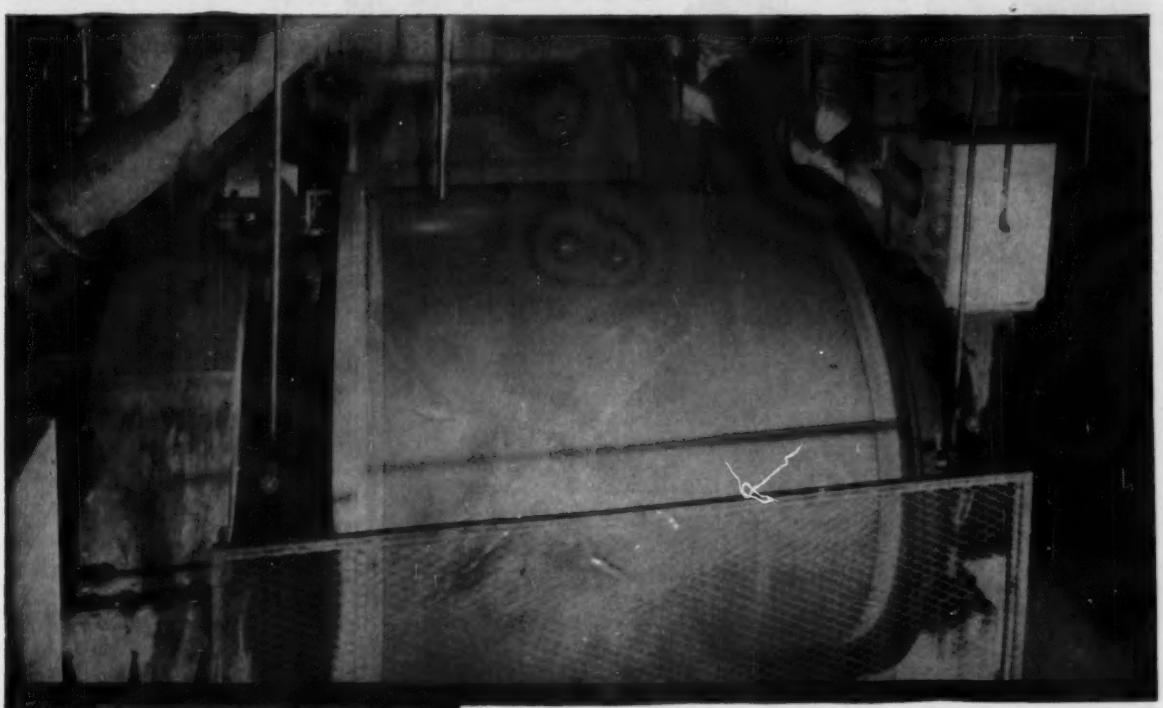
Although machines do not transcend human intelligence, they may and do transcend man in the performance of their tasks, being able to act more rapidly than human beings and perform the details of their operations more precisely. Machines also can learn, Dr Wiener pointed out. He related the techniques of machines to game playing.

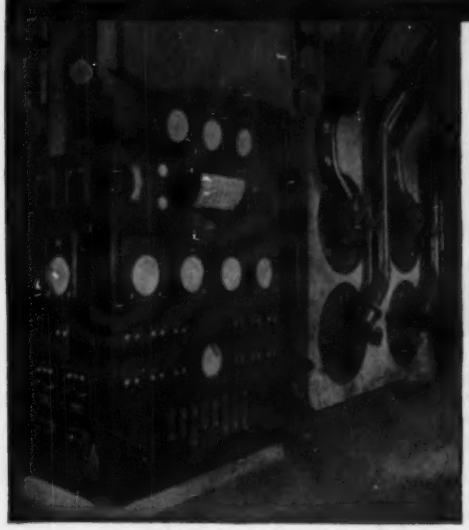
At their present level of learning, machines play a fair amateur game of chess but show a marked superiority to an opponent at checkers after 10 to 20 hours of working and indoctrination. A learning machine can make a rigid evaluation of plays according to value of pieces won or lost, command and mobility of pieces. When the machine comes to the point of weighting not merely moves as they occur in an individual game but a record of games previously played, it can become a tough antagonist. Tricks used at an earlier stage now fail to deceive it. This learning machine with its flexible game personality escapes complete effective control of the men who made it.

Self-programing technique of automization leaves the designer and operator no effective understanding of many of the stages by which the machine comes to its conclusions and of intentions of many of its opera-


For more facts circle 327 on Reader Service card, p 133

# KENNEDY Pulverized Coal Firing System





## . . . For Economy!

Shelby, Ohio—Municipal Light Department selects KENNEDY Pulverized Coal Firing System for 90,000 lb./hour steam plant generating 475 psig steam.

Shelby chose pulverized coal because of the availability of low cost coal, improved combustion efficiencies and lower stack losses, and because of its instant response to demand changes.

Shelby chose KENNEDY because no other pulverized coal firing system includes these desirable features:

- Fully air swept
- Coal pulverized to superfineness
- Coal completely carbureted, ready for combustion
- Big trunnions for air sweeping
- Balls added without shutting down
- Low operating and maintenance costs
- 85 to 90% through 200 mesh
- 20% moisture removed while pulverizing
- Pulverizes any coal—bituminous, anthracite or coke
- Tramp iron aids in pulverizing
- Reserves of fuel for fast response to demand

Consult KENNEDY before you specify your next firing system.

**KENNEDY VAN SAUN**
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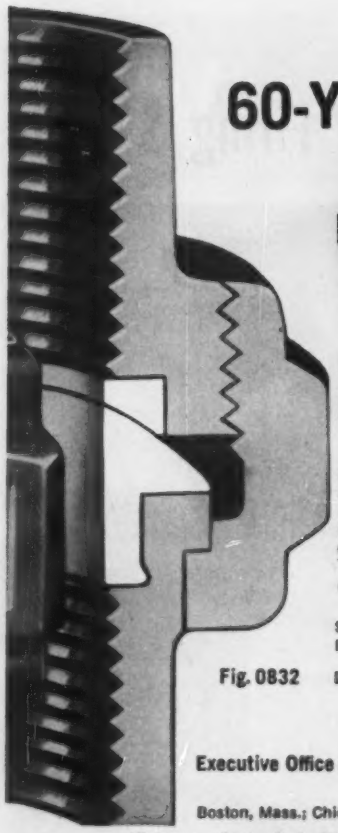

# 60-Year Guarantee Backs Dart Unions

**For over 60 years every Dart Union has been backed by the firm GUARANTEE that "if one should leak through, we will give you two". Less than 1 in every 100,000 has proven faulty.**

The extra wide bronze seats, ground on specially designed machines to a true ball and socket joint, are swaged under heavy pressure into air-refined malleable iron bodies. They come apart readily and remake repeatedly without excessive wrenching — without jamming. They are the reason that Darts may be used over and over again.

Sizes: ⅛" thru 4 inches
Pressure ratings: ⅛"-2"— 300 S.W.P., 600 W.O.G.
2½"-4"— 250 S.W.P., 600 W.O.G.
Darts also available in the all-iron construction.

Fig. 0832

THE **Fairbanks** COMPANY
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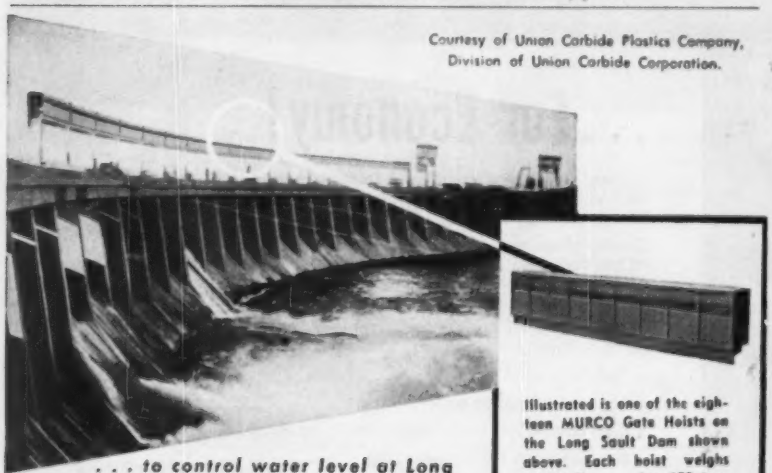

Courtesy of Union Carbide Plastics Company, Division of Union Carbide Corporation.

*. . . to control water level at Long Sault Dam, St. Lawrence Power Project*

# MURCO GATE HOISTS

Illustrated is one of the eighteen MURCO Gate Hoists on the Long Sault Dam shown above. Each hoist weighs 93,000 lbs. . . . has 175 tons lifting capacity . . . will raise and lower the gates in the dam at a speed of 1 foot per minute. The overall length of each unit is 57 feet . . . 8½ feet wide and 12½ feet high. Write for complete information and Engineering Department recommendations.

For the second largest hydroelectric power plant in the United States at Massena, New York—as part of the St. Lawrence power project—Uhl, Hall & Rish, project engineers, selected MURCO Gate Hoists to control the water level at Long Sault Dam. MURCO Gate Hoists are designed from knowledge and experience . . . backed by over 75 years in design and manufacture . . . made for any size power dam . . . capacities from less than 1 ton to over 100 tons . . . from the smallest hand operated to the largest motor operated gate hoist, all made to specifications.

*Manufacturers Since 1883*

MURCO

D. J. MURRAY MANUFACTURING CO.
WAUSAU, WISCONSIN

For more facts circle 331 on Reader Service card, p 133


## Reports from the field

Begins on page 194

tions. Operating on its incoming data faster than the human mind can understand, the machine does not wait for the already-postponed supposed ability of human control to catch up with it.

The human brain is a far more efficient control apparatus than is the intelligent machine when it comes to higher logical types. But Dr. Wiener reminds that intelligence and subservience do not go together. He warns that if we use a mechanical agency of such ironclad accuracy and speed that we cannot efficiently interfere after we have started its action, we had better be quite sure of the purpose put to it.

### Austria, Eastern Neighbor will share Danube power plant

**Vienna, Austria** (*McGraw-Hill World News*)—Austria and Czechoslovakia have worked out a joint project in which an Austro-Czech company will utilize Danube waters for power. Cost of the plant is estimated at $116,054,158, 50% to be supplied by Austria, the other half by Czechoslovakia. Investment and output will be split fifty-fifty, according to plans.

Annual yield is expected to reach 1130-million kwkr, roughly 10% more than the Austrian Ybbs-Persenbeug (Danube-run-of-river) plant will yield when finished. Construction period is estimated at four years. Agreement, initialed 18 months ago, is ratified only by Austria so far.

### Plastics field may grow to industrial giant

Plastics could well become second only to steel as a basic material, C M Christie, president of Dayton Rubber Company, said before the Los Angeles Society of Security Analysts. Unrest in nation-wide steel negotiations may have helped to speed the acceptance of plastics by causing manufacturers to turn to other materials to conserve and stretch steel

AI's extensive field laboratory is located in California's Santa Susana Mountains. *Woodcut by Edward Kysar.*

# How can A.I. facilities help you plan a Nuclear Program?

In the picturesque Santa Susana mountains near Los Angeles, Atomics International has built an extensive field laboratory for research, engineering and testing in the nuclear sciences. Here, and at a headquarters complex in the valley below, men who pioneered the creative uses of atomic energy are applying their experience to develop advanced nuclear reactors and associated equipment.

Fourteen years of experience in developing various types of reactors for the Atomic Energy Commission and other organizations have given the men of Atomics International a collective background unparalleled in the industry. The facilities at their disposal are among the most sophisticated and extensive in the world.

Results of AI's work have been demonstrated in projects for the AEC which include the Organic Moderated Reactor Experiment at the National Reactor Testing Station in Idaho and the Sodium Reactor Experiment at the company's field laboratory. Additionally, AI built and is operating SNAP II, a 220 pound prototype reactor to produce three kilowatts of electricity for space vehicles.

Atomics International is also building large power reactors for electric utilities in Ohio and Nebraska under AEC programs. Studies are underway for other power reactors in the United States and Europe. Research reactors have been built by AI for Denmark, Germany, Italy, Japan, Puerto Rico and several sites in the United States.

For details contact: ATOMICS INTERNATIONAL, Canoga Park, California, U.S.A. Cable address: ATOMICS.

**ATOMICS INTERNATIONAL**
A DIVISION OF NORTH AMERICAN AVIATION, INC.
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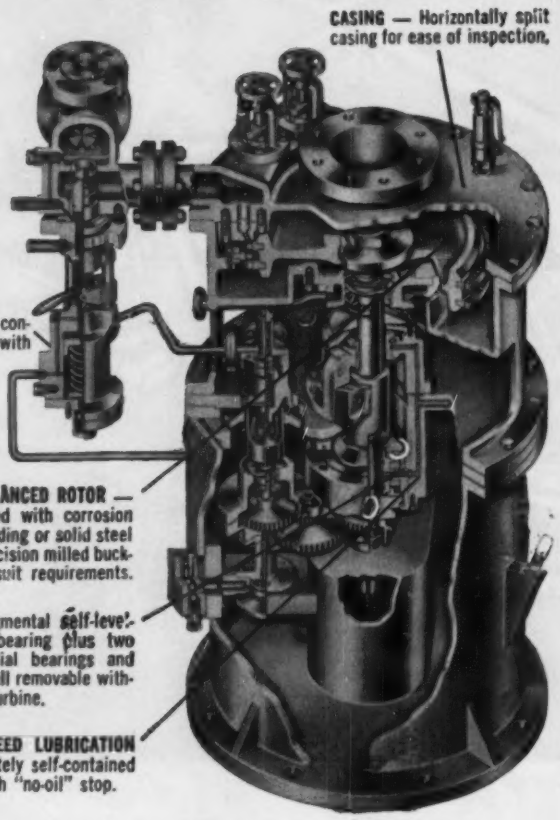
Other offices in: Washington, D.C., U.S.A.; Geneva, Switzerland. Affiliated with: INTERATOM, Bensberg/Cologne, Federal Republic of Germany and DYNATOM, Paris, France.

# NEW Whiton VERTICAL TURBINE

## Type BHBSV for Vertical Pump Drives



**CASING** — Horizontally split casing for ease of inspection.

**SPEED CONTROL** — Oil constant speed governor with overspeed stop.

**DYNAMICALLY BALANCED ROTOR** — Either steel forged with corrosion resistant steel blading or solid steel one piece with precision milled buckets available to suit requirements.

**BEARINGS** — Segmental self-leveling type thrust bearing plus two babbitt lined radial bearings and shaft packing — all removable without dismantling turbine.

**FORCED FEED LUBRICATION** — Completely self-contained system with "no-oil" stop.

The Whiton Vertical Turbine is extremely versatile, compact and dependable . . . ideal for vertical pump drives and other similar applications. The vertical design requires minimum installation space and allows great freedom of location. Simplicity of design and construction results in ease of operation and servicing.

With this vertical turbine added to the line, Whiton's vertical and horizontal steam turbines offer a broad range of power supply applications. Complete data on the new vertical turbine and others available on request.

| MAXIMUM OPERATING SPECIFICATIONS | |
|---|---|
| POWER | to 1000 HP |
| SPEED | to 8500 RPM |
| STEAM PRESSURE | to 1250 PSIG |
| STEAM TEMPERATURE | to 1050 FTT |

Whiton SINCE 1856

THE WHITON MACHINE COMPANY
NEW LONDON, CONNECTICUT


## Reports from the field

Begins on page 194

supplies. This left the door wide open for highly versatile plastics.

Christie predicted Dayton Rubber would have total sales in 1960 in excess of 120 million dollars. He said largest gains are expected in plastics, particularly urethanes. These resist elements, have excellent insulating qualities and are lightweight. Chemically inert, they bond permanently to any surface.

### Soviets use fresh peat in boilers

**Vienna, Austria** (*McGraw-Hill World News*) — Latvian engineers have developed a process which makes it possible to use freshly cut peat in boilers. Exploitation of peat for electric power dates back to 1899 when German engineer Gehrke started tests. No really profitable processing technology has been devised up to now.

Latvian system first places peat, freshly cut into small bricks, in a dry-heat furnace where constant saturation temperature is maintained. Peat is then brought into contact with superheated steam in another chamber. Under constant mechanical turning, more steam is gained from the material. Dry peat passes on to boiler's fire room where it is used for low-Btu fuel. Entire process takes between 10 and 15 min; test plant yields 572-lb steam per hr.

### Corrosion protection called cheap insurance

Corrosion protection should be built in when new pipeline pumping stations are planned; it is cheap insurance even in existing plants, Plantation Pipe Line Co electrical engineers said in a technical paper presented at the Winter General Meeting of AIEE. Paper describes corrosion protection measures on pipeline utilizing electric pumping stations at 30- to 60-mile intervals.

"Coating of buried metallic structures is not the total answer to corrosion prevention at product pipeline pumping stations — the coating of



For more facts circle 333 on Readers Service card, p 133

circle 334 on Reader Service card, p 133

CLEARWATER FINISHING
GETS SAVINGS
WITH INTEREST,
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# PACKAGE AIR PREHEATER

***Fuel savings alone pay for it in two years; installation costs cut by pre-assembly — —***

Savings come in pairs at Clearwater Finishing Co., with the installation of their new Package Air Preheater. This is why:

***1. Initial savings on installation.*** You can install a Package Air Preheater at a fraction of the expense required for conventional heat recovery equipment. The unit you see in the picture is a *complete* Package Air Preheater. To put it into service you simply lift it into place, make power and duct connections. It's that fast, that easy.

***2. Long term fuel savings*** . . . $17,000 a year off your fuel bill (more or less, depending on size of preheater and application). What you save on fuel can pay for the Package Air Preheater within two years.

Installation savings are achieved through standardized design, which permits complete shop assembly. Fuel savings are achieved through the efficient continuous regenerative heat recovery principle, which cuts your fuel bill 1% for each 45-50°F increase in preheated air temperature.

For application ideas, and facts and figures on the potential savings, write for free 14-page booklet.

*Completely pre-assembled Package Air Preheater is lifted into place at the new plant of Clearwater Finishing, (Division of United Merchants & Manufacturers, Inc.) at Clearwater, South Carolina. Installed at far less cost than a unit requiring on-site erection, this Package Air Preheater will serve a 83,000 lb/hr boiler. It measures approximately 8'x8'x6', and its 4900 sq ft of effective heating surface will recover 290°F from the stack gas.*

## THE AIR PREHEATER CORPORATION

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# Quiet, Efficient, Convenient

**Ideal for Hospitals, Hotels, Apartments, and Industries where noise is objectionable.**

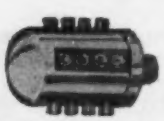
Rotojet Electric Tube Cleaner thoroughly cleans straight tubes from 25/32" to 4" I.D. in boilers, condensers, evaporators, and heat exchangers so quietly that it can be operated without disturbing anyone.

This self-contained unit comprises a powerful motor, rotatably mounted on a stand, a required length of heavy duty flexible shaft, a 20 ft. cable, and a selection of heads, brushes, drills, and scrapers to meet any cleaning need. The motor swivels and rotates so that tubes on top, bottom, and sides can be cleaned without moving the unit. A few of the many types of heads available are shown below.

Bulletin 107 gives full details of this quiet, efficient, convenient tube cleaner. Send for it now.

Rotojet Electric Tube Cleaner with swing-frame head.

4-way drill and universal coupling.



Expanding wire brush.

ELLIOTT COMPANY – ROTO PLANT
*Tube Cleaner Specialists Since 1910*
153 Sussex Avenue, Newark, N. J.


## Reports from the field

Begins on page 194

sump tanks, water separator, bottoms of water tanks, piping and conduits assures long service life only if it is supplemented with cathodic protection," they said. Cathodic protection for an existing station is difficult but planning in the initial stages of construction solves many problems. If equipment is part of original installation, costly hand-ditching around piping and under paved drives can be eliminated. Savings on only one or two leaks under concrete station floors can cover the original cost, they maintained.

### Sea tides will power Soviet station

**Vienna, Austria** (*McGraw-Hill World News*) — First tidal electric station in the Soviet Union is being planned for the eastern part of the Mezen Bay, White Sea, where tides measure approximately 7 to 10 meters. A 100-km sectional ferroconcrete dam will span this part of the bay. It will have 2000 turbines. Electricity generated by this station will be fed into the unified grid of the Urals and European part of the Soviet Union

Although stations utilizing the energy of sea tides have a fluctuating operating capacity caused by ebb and flow of the tide, Soviet engineers feel that a great advantage lies in the constant mean monthly tidal energy.

Prefabricated, rectangular, reinforced concrete slabs up to 10-cm thick will be used to build the station. Bulb type turbogenerators will also be used. They will need no machine covering as they will be fully submerged.

### Hungarians uncover fuel-saving invention

**Vienna, Austria** (*McGraw-Hill World News*)—Hungarian invention is said to achieve considerable savings in operation of furnaces for heating purposes if low-grade oil is used instead of gas. Invention deals with gasification of pressurized fuel oil. Gasification process allows bet-

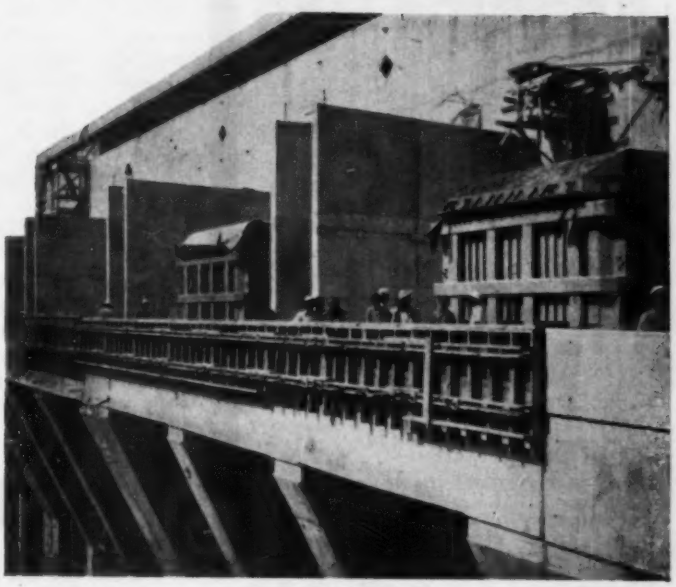
# HITACHI

Casing for 150,000 HP Francis Turbine for the Bhakra Power Station, India.

## Another Big Power Project for Hitachi

When the Government of Punjab, India, called for international tenders for the big Bhakra Dam Power Plant No. 1, to consist of five complete sets of generating equipment, Hitachi was awarded a contract for five 150,000 HP hydraulic turbines in the face of spirited competition.

The output of these turbines was originally planned to be 125,000 HP but it was decided to increase this to 150,000 HP (112,000 KW) at the normal head of 400 feet (122 meters) in view of the capacity of the generators. These are rated at 100,000 KVA and 0.9 power factor, and capable of continuous operation under a 15% overload. At the maximum head of 512 feet (156 meters) the turbines can deliver 200,000 HP but their output over the normal head will be limited to 150,000 HP to co-ordinate their capacity to that of the generators.



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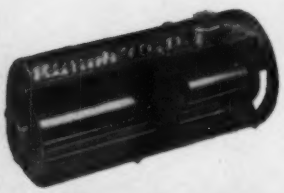
# MAXIM

# MEANS EFFICIENT HEAT RECOVERY PLUS RESIDENTIAL TYPE SILENCING



In a single packaged unit, Maxim Heat Recovery Silencers do the job of both boiler and silencer. This saves the cost of installing two separate pieces of equipment, conserves valuable space, and minimizes back pressure.

Because Maxim equipment operates either wet or dry, your diesels can run continuously even if waste heat is used only intermittently. Highly efficient for recovery of waste heat, Maxim Heat Recovery Silencers combine this with the optimum in noise suppression—of special importance in populated areas.

Maxim offers the most complete line available—vertical and horizontal models for a wide range of conditions and capacities. Send coupon for full information.

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ter intermixture with atmospheric air. This yields more Btu's than ordinarily injected fuel oil.

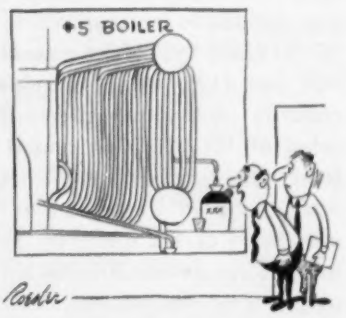
Early tests conducted with several industrial furnaces having new burners for long-term test purposes showed considerable savings, according to Hungarian state news agency, MTI. Another saving: with gasification process, large amounts of coal and cooking gas will be available for other utilization.

### Revised breaker-testing rules available

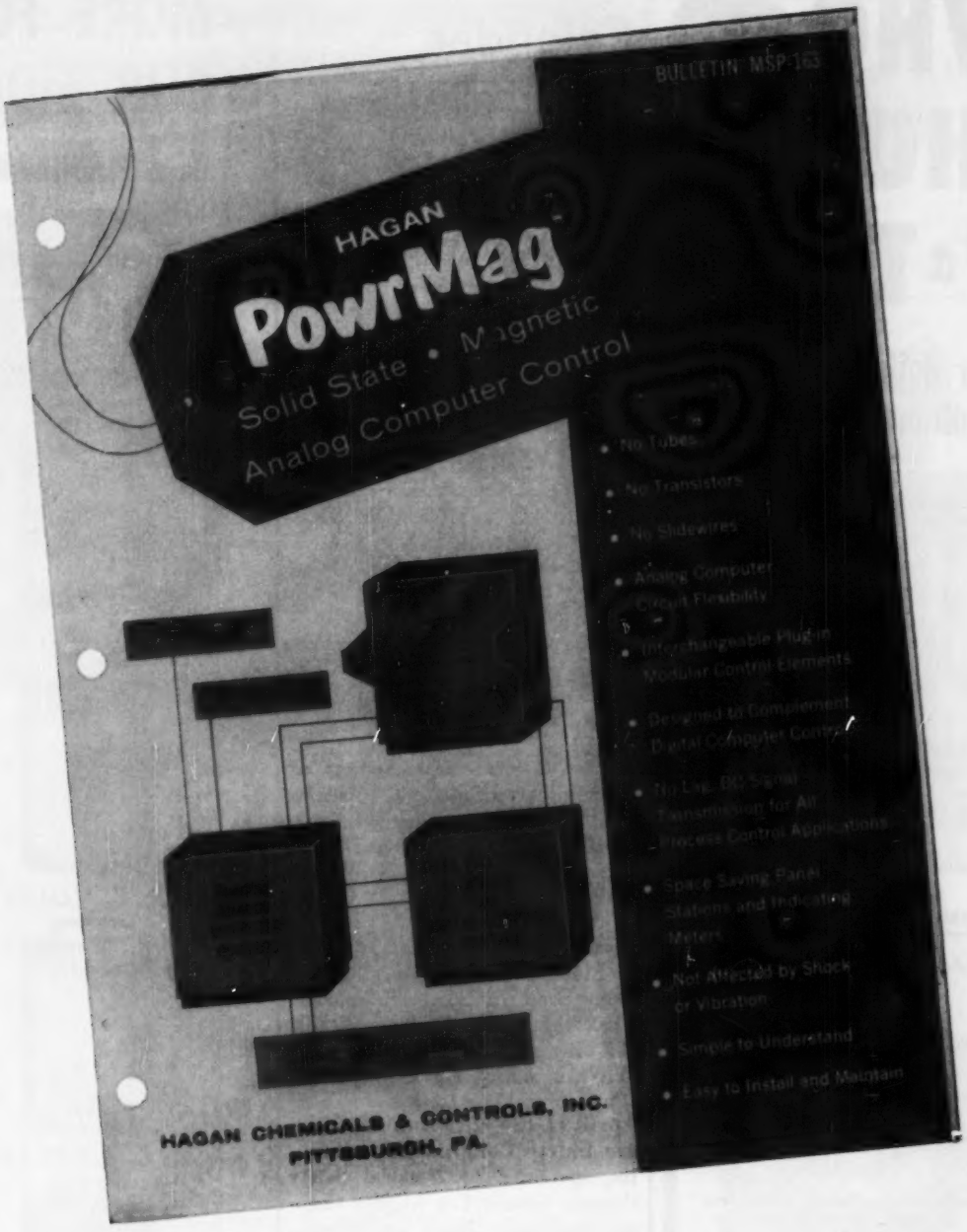
An increase since 1950 in variety of switching equipment which operates in series with fuses or fuse links has necessitated a revision of the 1950 ASTA publication 9.

Because the circuit breaker or switch operates up to a prescribed limit of overcurrent in this equipment, above which the fuse link or fuse takes over full breaking capacity of the equipment, experience gained in short-circuit testing of this type of equipment has made the revision possible.

The Association of Short-Circuit Testing Authorities has published ASTA 22 which supersedes the 1950 edition, "Rules for Short-Circuit Testing of Circuit Breakers in Combination with Back-Up Fuses". This document also takes into consideration high-voltage automatic fuse switches.




*"Quick! See what that boiler-room gang's up to!"*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**Send for this bulletin.** Hagan's PowrMag analog computer control offers the highest degree of flexibility yet devised for industrial control. A new bulletin, MSP-163, shown above, gives full details on the system, the magnetic control units, the patchboard, and provides useful information on determining computer requirements.

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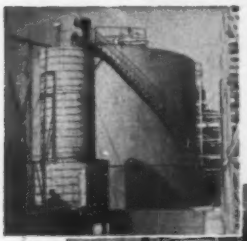
# WHO CHOSE H&T?

## For Boiler Feedwater Conditioning Equipment



400,000 lb. per hour fully automatic demineralizer plant with silica and $CO_2$ removal

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# Calendar

**April 4-7—Nuclear Congress,** Coliseum, New York. Details: Congress Office, 29 W 39th St, New York 18, N. Y.

**April 5-7—Instrument Society of America,** 3rd National Chemical and Petroleum Instrumentation Symposium, Rochester, N. Y. Details: ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

**April 6-7 — Lead Industries Association,** 32nd Annual Meeting, Chase-Park Plaza Hotels, St. Louis, Mo. Details: D M Borcina, LIA, 60 E 42nd St, New York 17, N. Y.

**April 6-7—Oil Heat Institute of America, Inc,** 38th Annual Convention, Coliseum, New York. Details: OHI, 500 Fifth Ave, New York 36, N. Y.

**April 7-8—American Society of Mechanical Engineers,** Management Engineering Conference, Statler Hilton Hotel, New York. Details: L S Dennegar, ASME, 29 W 39th St, New York 18, N. Y.

**April 11-13—American Institute of Electrical Engineers,** Electrical Engineering in Space Technology, Baker Hotel, Dallas, Texas. Details: R C Mayer, 51 E 42nd St, New York 17, N. Y.

**April 11-13—7th Annual Western Safety Congress and Exhibits,** sponsored by National Safety Council, Greater Los Angeles Chapter, Ambassador Hotel, Los Angeles. Details: J M Kaplan, 3388 W 8th St, Los Angeles 5, Calif.

**April 18-19—Joint Conference on Automatic Techniques,** sponsored by ASME, AIEE, IRE, Sheraton Hotel, Cleveland, Ohio. Details: L S Dennegar, ASME, 29 W 39th St, New York 18, N. Y.

**April 19-21—American Society of Lubrication Engineers,** 15th Annual Meeting and Lubrication Exhibit, Netherland Hilton Hotel, Cincinnati, Ohio. Details: C L Willey, 84 E Randolph St, Chicago 1, Ill.

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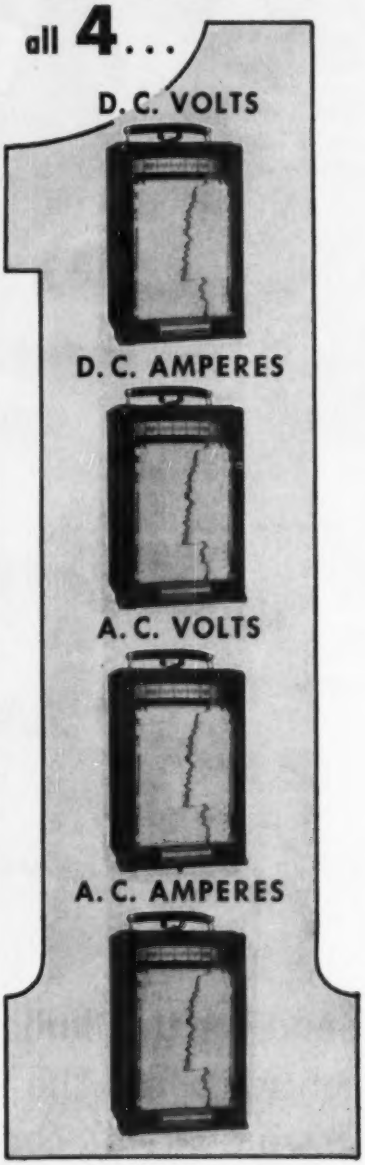


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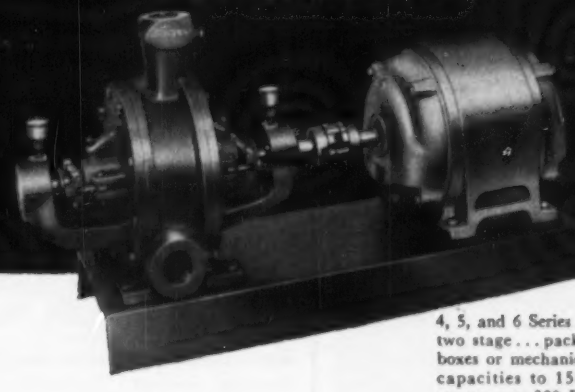

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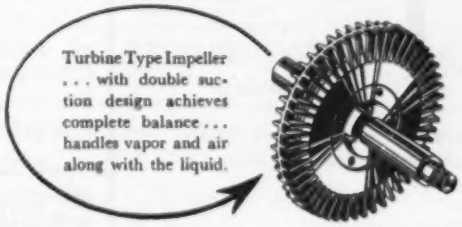

Turbine Type Impeller . . . with double suction design achieves complete balance . . . handles vapor and air along with the liquid.

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THE NEW YORK AIR BRAKE COMPANY
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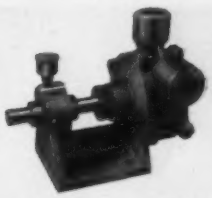

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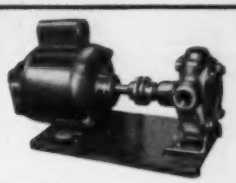
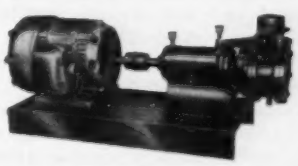


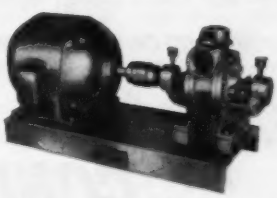
32 Series . . . single stage flexible coupling drive . . . mechanical seal . . . lubricated-for-life bearings . . . capacities to 10 GPM, heads to 250 feet. Ask for Bulletin U-111-B.

Type V31 . . . single stage close coupled . . . mechanical seal . . . self priming . . . capacities to 15 GPM, heads to 350 feet. Ask for Bulletin V-111-A.

Type V4 . . . close coupled . . . single stage . . . mechanical seal . . . capacities to 30 GPM . . . heads to 350 feet. Ask for Bulletin V-111-B.



Type Z4 Chemical Process . . . single stage or two stage . . . mechanical seal . . . capacities to 50 GPM . . . pressures to 400 PSI. Ask for Bulletin Z-111-A.



Type X40 . . . water jacketed packed stuffing boxes or mechanical seals . . . single or two stage . . . capacities to 60 GPM . . . heads to 350 feet. Ask for Bulletin 111XJ.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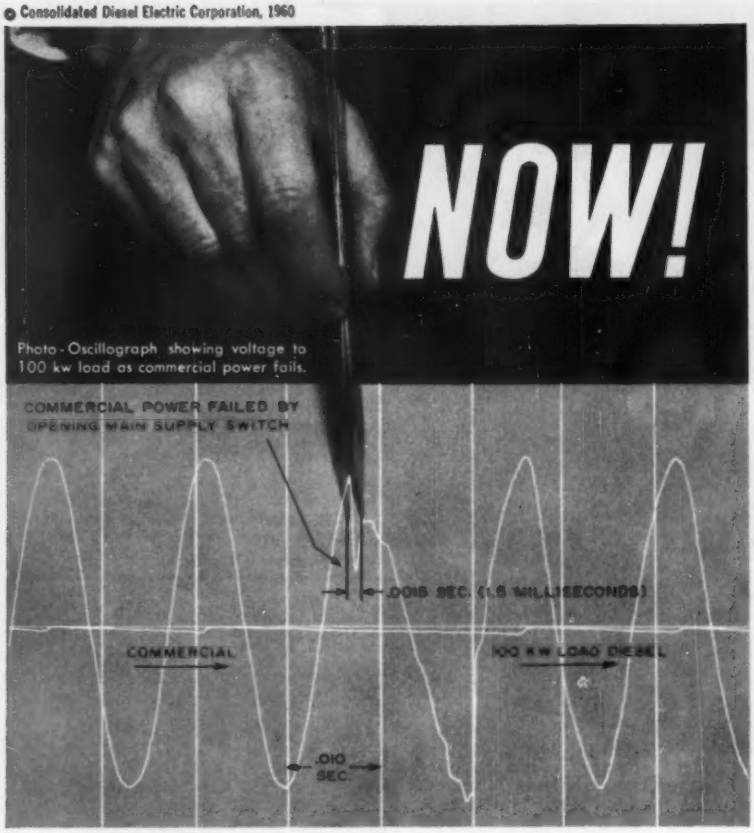
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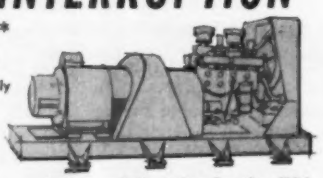
**POWER WITHOUT INTERRUPTION with CONDEC'S UPS***

*Uninterrupted Power Supply



Unlike conventional standby generator units, Condec's Uninterrupted Power Supply means power without interruption whenever prime source fails. Controls, relays, lights, radar scopes, computers don't even flicker or pause.

This instantaneous transfer, from prime to UPS generation, with full voltage restoration in 1.5 milliseconds provides the every-second power protection essential to key industrial operations like processing, telemetering, pipelines, automated production lines, as well as such military uses as communications, radar, aircraft and missile ground support.

**What the Condec UPS does for you**

- Automatic emergency power 5 to 200 kw without interruption.
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- Unattended operation. Automatic synchronization and automatic return to standby.

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## Calendar

Begins on page 216

**April 19-21 — Microwave Research Institute,** Symposium on Active Networks and Feedback Systems, Polytechnic Institute of Brooklyn, New York. Details: Microwave Research Institute, Polytechnic Institute of Brooklyn, 55 Johnson St, Brooklyn 1, N. Y.

**April 21-22—American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc,** Pacific Southwest Regional Metals & Minerals Conference, Ambassador Hotel, Los Angeles, Calif. Details: AIME, 29 W 39th St, New York 18, N. Y.

**April 21-22—Illuminating Engineering Society,** South Central and Southeastern Regional Conference, Peabody Hotel, Memphis. Details: J F Fletcher, Standard Electric Co, 876 Vance Ave, Memphis, Tenn.

**April 25-26—Illuminating Engineering Society,** Southwestern Regional Conference, Robert Driscoll Hotel, Corpus Christi. Details: B L Guess Jr, 1210 York Ave, Corpus Christi, Texas.

**April 25-26—American Society of Mechanical Engineers,** Maintenance and Plant Engineering Conference, Chase-Park Plaza Hotel, St. Louis, Mo. Details: L S Dennegar, ASME, 29 W 39th St, New York 18, N. Y.

**April 25-29 — American Society of Mechanical Engineers,** Metals Engineering Division—AWS Conference, Biltmore Hotel, Los Angeles, Calif. Details: L S Dennegar, ASME, 29 W 39th St, New York 18, N. Y.

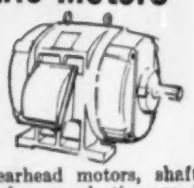
**April 27-29—American Institute of Electrical Engineers,** Great Lakes District Meeting, Milwaukee, Wis. Details: R C Mayer & Assoc, 51 E 42nd St, New York 17, N. Y.

**April 27-30—Western Air Conditioning, Heating, Ventilating and Refrigeration Exhibit and Conference,** sponsored by Western Air Conditioning Industries Association, Shrine Exposition Hall, Los Angeles. Details: F J Tabery, 3443 South Hill St, Los Angeles 7, Calif.

continued

# CONDEC
## Products for Power

### Lima Electric Motors



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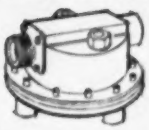

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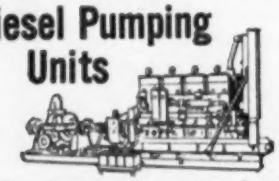
### Diesel Pumping Units



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The Lima Electric Motor Co., Inc.

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## Calendar

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**April 28-29 — Illuminating Engineering Society,** Inter-Mountain Regional Conference, Mountain Shadows Hotel, Scotsdale, Ariz. Details: D L Ruff, Arizona Public Service Co, P.O. Box 2591, Phoenix, Ariz.

**April 28-30—American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc,** Pacific Northwest Regional Conference, Sheraton Hotel, Portland, Oregon. Details: AIME, 29 W 39th St, New York 18, N. Y.

**May 2-3—American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc,** 4th Biennial North Texas Secondary Recovery Symposium, Wichita Falls, Texas. Details: AIME, 29 W 39th St, New York 18, N. Y.

**May 2-3—Instrument Society of America,** Electrical Safety Instrumentation Symposium, Wilmington, Del. Details: ISA, 313 Sixth Ave, Pittsburgh, Pa.

**May 4-6—Illuminating Engineering Society,** South Pacific Regional Conference, Ambassador Hotel, Los Angeles. Details: W Shalda, Shalda Mfg Company, P.O. Box 507, Burbank, Calif.

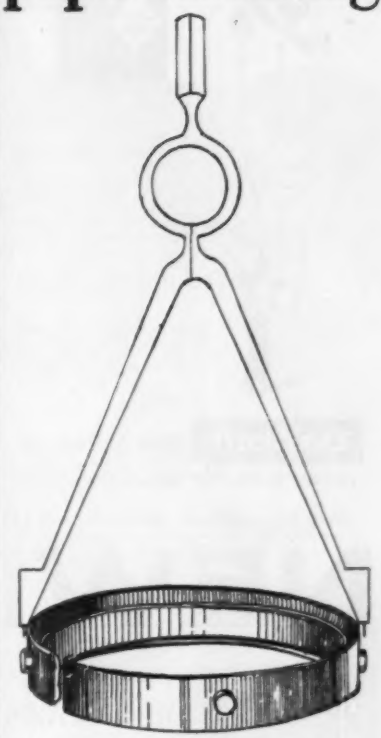
**May 5-6—American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc,** Rocky Mt Petr Sections, Annual Joint Meeting, Calgary, Alberta, Canada. Details: AIME, 29 W 39th St, New York 18, N. Y.

**May 9-10 — Illuminating Engineering Society,** Pacific Northwest Regional Conference, Benjamin Franklin Hotel, Seattle. Details: G D King, Sylvania Electric Products, Inc, 3466 E Marginal Way, Seattle, Wash.

**May 9-11 — Instrument Society of America,** 3rd National Power Instrumentation Symposium, San Francisco, Calif. Details: ISA, 313 Sixth Ave, Pittsburgh, Pa.

**May 9-12—Instrument Society of America,** 2nd Instrument-Automa-


# THE POWER ENGINEERS solution to pipe welding



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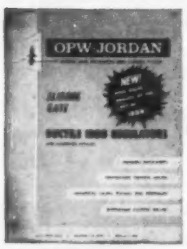


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## Calendar

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tion Conference and Exhibit of 1960, Civic Auditorium and Brooks Hall, San Francisco, Calif. Details: ISA, 313 Sixth Ave, Pittsburgh, Pa.

**May 9-13—American Society for Metals,** 2nd Southwestern Metal Exposition and Congress, State Fair Park and Sheraton Hotel, Dallas, Texas. Details: A R Putnam, ASM, Metals Park, Novelty, Ohio

**May 11-14—Fluid Controls Institute, Inc,** 1960 Spring Meeting, White Sulphur Springs, W. Va. Details: E R Rath, P.O. Box 667, Pompano Beach, Fla.

**May 12-13—Illuminating Engineering Society,** Midwestern Regional Conference, Sheraton Martin Hotel, Sioux City. Details: M Lee, Iowa Public Service Co, Orpheum Electric Bldg, Sioux City 4, Iowa

**May 16-17 — Illuminating Engineering Society,** Great Lakes Regional Conference, Carter Hotel, Cleveland. Details: R D Churchill, General Electric Company, Nela Park, Cleveland, Ohio

**May 16-20—National Fire Protection Association,** Annual Convention, Queen Elizabeth Hotel, Montreal, Quebec, Canada. Details: D Richardson, 60 Batterymarch St, Boston 10, Mass.

**May 17-19 — American Society of Mechanical Engineers,** Production Engineering Conference, Schroeder Hotel, Milwaukee, Wis. Details: L S Dennegar, ASME, 29 W 39th St, New York 18, N. Y.

**May 18-20—Society for Experimental Stress Analysis,** Spring Meeting, Hotel Severin, Indianapolis, Ind. Details: SESA, P.O. Box 168, Cambridge 39, Mass.

**May 18-21—National Institute of Disaster Mobilization, Inc,** 4th Annual Industrial Mutual Aid & Disaster Control Conference, Cincinnati, Ohio. Details: NIDM, 475 Fifth Ave, New York 17, N. Y.

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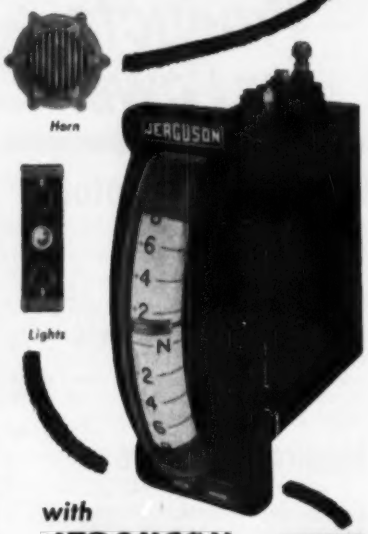


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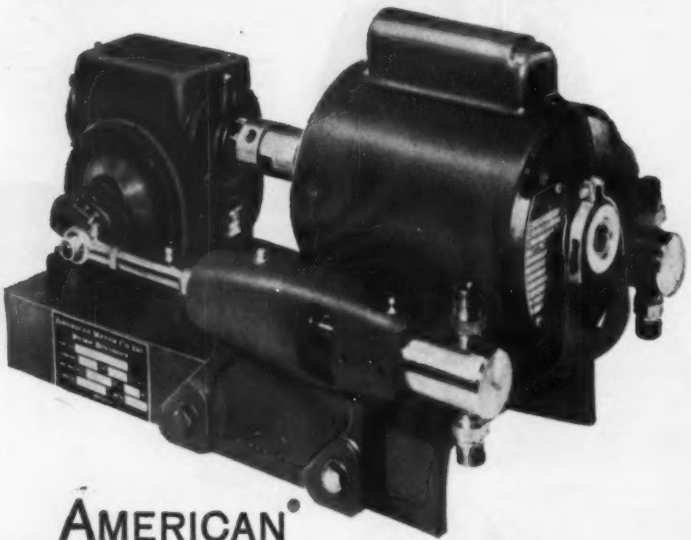

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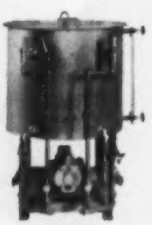

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## Calendar

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**May 22-26 — American Society of Mechanical Engineers,** Oil and Gas Power Conference and Exhibit, Muehlebach Hotel, Kansas City, Mo. Details: L S Dennegar, ASME, 29 W 39th St, New York 18, N. Y.

**May 23-25—Instrument Society of America,** 9th Annual Telemetering Conference, Miramar Hotel, Santa Barbara, Calif. Details: ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

**May 23-26—American Society of Mechanical Engineers,** Design Engineering Conference and Show, Coliseum and Statler Hilton Hotel, New York. Details: L S Dennegar, 29 W 39th St, New York

**May 25-26—American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc,** Symposium on Refractory Metals and Alloys, McGregor Center, Wayne State Univ, Detroit, Mich. Details: AIME, 29 W 39th St, New York 18, N. Y.

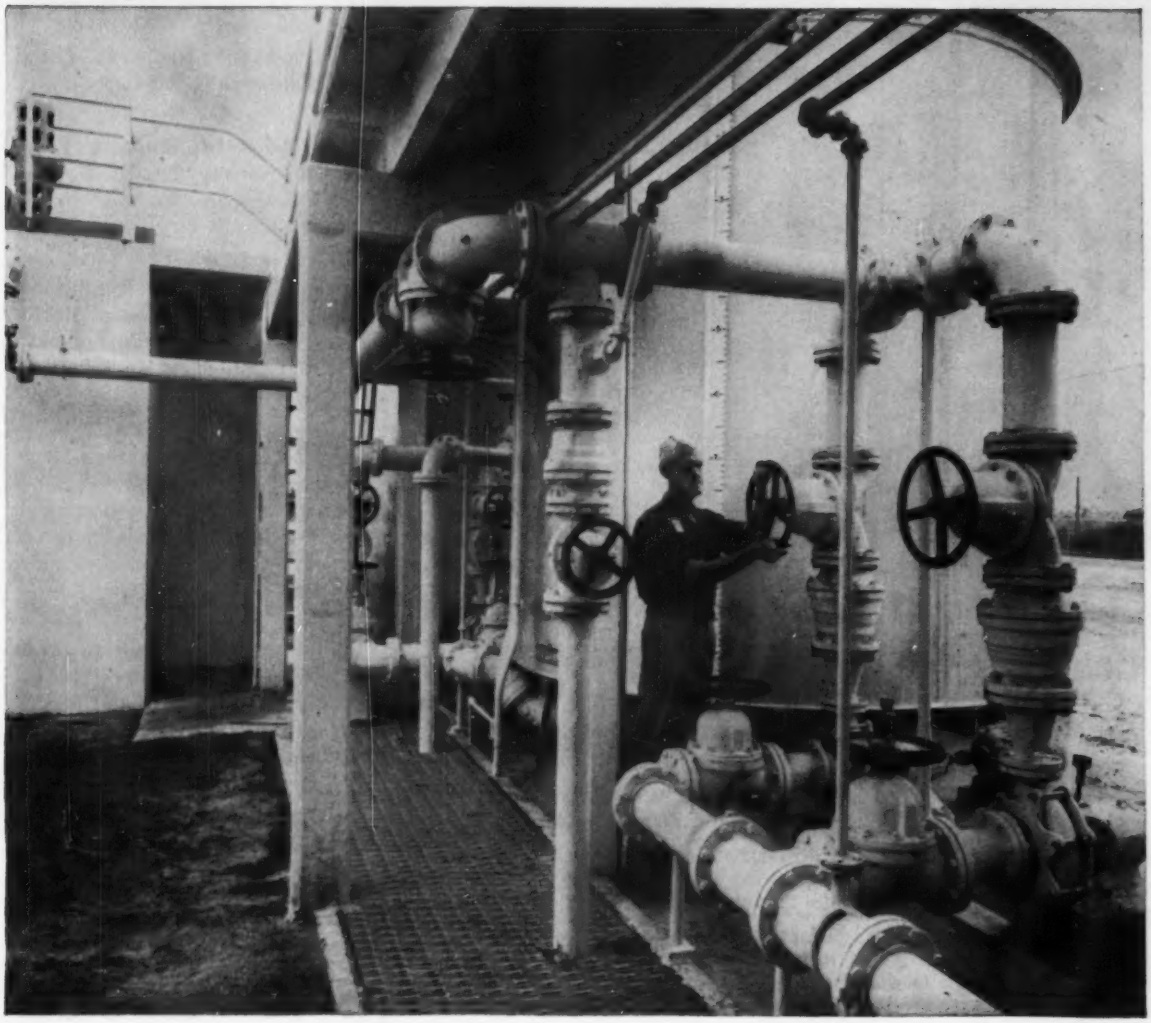
**June 1-3—Instrument Society of America,** 6th Annual Instrumental Methods of Analysis Symposium, Montreal, Canada. Details: 313 Sixth Ave, Pittsburgh, Pa.

**June 2-3—4th Annual Summer Conference on Vacuum Metallurgy,** University Heights, New York Univ College of Engineering. Details: D R Bunshah, New York Univ College of Engineering, University Heights 53, New York

**June 5-9—American Society of Mechanical Engineers,** Summer Annual Meeting, Statler Hilton Hotel, New York City. Details: L S Dennegar, ASME, 29 W 39th St, New York, N. Y.

**June 6-9—National District Heating Association,** Annual Meeting. Grove Park Inn, Ashville, North

DOW | **SARAN LINED PIPE**



## After 9,000,000 gallons of heated acids, plating waste ... No Corrosion in **SARAN LINED PIPE**

When piping and valves carry more than a million gallons a month of heated acid and plating waste solution . . . when failure in the line would peril essential plant operations . . . there can be no guessing about corrosion resistance. The situation calls for Saran Lined Pipe and valves!

Shown above is one of the Saran Lined Pipe installations in use at the Florida R & D Center, Pratt & Whitney Aircraft, Division of United Aircraft Corporation, United, Florida. This installation carries 1,100,000 gallons per month of solutions of chromic acid, hydrogen fluoride, potassium cyanide, nitric acid, phosphoric acid and other chemicals. The solutions are in transfer from the Plating Department to waste treatment areas, at an average temperature of 100°F.

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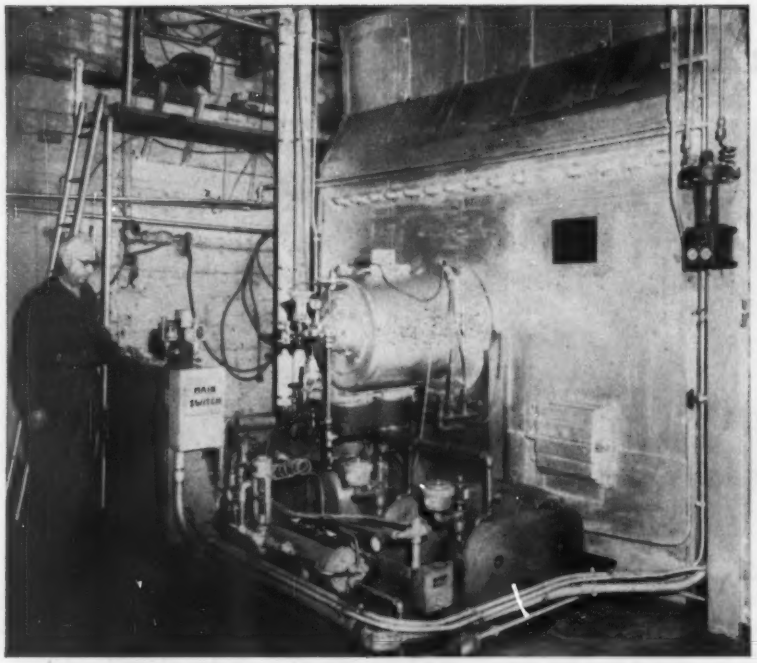

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## Calendar

Begins on page 216

Carolina. Details: NDHA, 827 Euclid Ave, Pittsburgh 6, Pa.

**June 8-9 — Illuminating Engineering Society,** Northeastern Regional Conference, Westworth-by-the-Sea, Portsmouth, N. H.

**June 10-26—British Exhibition,** sponsored by Federation of British Industries, Coliseum, New York. Details: A A Schechter, 551 Fifth Ave, New York 17, N. Y.

**June 13-14—Illuminating Engineering Society,** Canadian Regional Conference, Nova Scotian Hotel, Halifax, N. S. Details: H Lushington, Canadian General Electric Company, Ltd, Halifax, N. S., Canada

**June 19-22—American Institute of Chemical Engineers,** Spring Meeting, Del Prado Hotel, Mexico City. Details: AICHE, 25 W 45th St, New York 36, N. Y.

**June 20-22 — American Society of Mechanical Engineers,** Applied Mechanics Conference, Pennsylvania State Univ, University Park, Pa. Details: L S Dennegar, ASME, 29 W 39th St, New York

**June 20-24 — American Society for Engineering Education,** 68th Annual Meeting, Purdue University, Lafayette, Ind. Details: Purdue University, Lafayette, Ind.

**June 25-July 5—Instrument Society of America,** 1st International Congress for Automatic Control, AACC sponsored with ASME, IRE and AICHE cooperating, Moscow, USSR. Details: ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

**July 11-12—Conference of Response of Materials to High-Velocity Deformation,** sponsored by Physical Metallurgical Comm., Inst of Metals Div, TMS, Estes Park, Colorado. Details: AIME, 29 W 39th St, New York 18, N. Y.



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# Appointments

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**General Dynamics Corporation's** General Atomic Div manager of nuclear-power applications will be Titus G LeClair. He is presently manager of research and development for Commonwealth Edison Company.

LeClair is a recognized leader in the development of nuclear power for central-station generation of electricity. He has been an official of the Nuclear Power Group, Inc which co-sponsored Commonwealth Edison's recently completed Dresden nuclear power plant at Joliet, Ill. He also has served the Atomic Energy Commission and Joint Congressional Committee on Atomic Energy in advisory capacities.

LeClair is a native of Wisconsin and an engineering graduate of the University of Idaho from which he received an honorary doctorate of science in 1951. He has been president of Engineers Joint Council, Illinois Engineering Council, Western Society of Engineers and American Institute of Electrical Engineers.

He recently headed a committee established by the Atomic Industrial Forum to develop procedures for use by the government and electric-generating industries in evaluating nuclear-power reactors.

continued

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Outlet or regulated pressure spring ranges are 5-35, 20-60, 40-90.

This valve also is made with reverse seating arrangement to operate as a relief valve.

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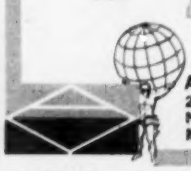

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*and carries a Lifetime Guarantee!*

In the electrostatic precipitation of dust, fume and fly ash, no installation is completely modern without *automatic* control to maintain optimum Precipitator efficiency as the characteristics of the gas stream fluctuate. Compared with manual control, automatic control is not only more sensitive and more efficient, but actually costs less because of the vital savings it makes in labor and operating costs . . . *savings so important that no profit-minded operator will want to be without them.*

***But the important point to remember is this*** — Although many manufacturers of precipitation equipment offer units for precipitator automation, no other unit is equal to the "Transistomatic" Control for foolproof simplicity, rugged dependability or control accuracy!

***These are not idle claims. They can be easily verified by making your own comparison . . .***

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***Compare* ACCURACY!** The "Transistomatic" does not base its "sensing" action on spark *frequency* alone—or spark *intensity* alone. Instead, it continuously integrates BOTH frequency and intensity to establish an overall "power value" that provides a new standard of control accuracy!

***Compare* DEPENDABILITY!** The "Transistomatic" unit contains no parts of any kind requiring regular replacement. Moreover, the entire unit is completely sealed—moisture-proof and watertight.

***Compare* GUARANTEES!** The "Transistomatic" is so foolproof and trouble-free it carries a *lifetime guarantee!*

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# Good Pair to Know!

Chances are you won't have to look far to find a spot for one of these float-operated switches.

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## McDonnell No. 65
### Explosion Proof Electric Controller

*Underwriters' Listed for use in hazardous locations:*
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A float-operated switch for use under hazardous conditions, such as atmospheres containing butane, benzol, lacquer solvent, alcohols, acetone, coal and grain dust, etc. Can be furnished to make or break electric circuit at high- or low-level — to control motors, signal lamps, electric elements, etc. Suitable for internal pressures up to 40 psi.

Write for McDonnell Engineering Bulletin ERS-10 which discusses typical applications of No. 65, shows wiring diagrams for different patterns of operation.

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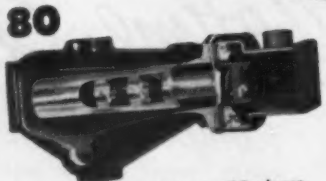
### High- or Low-Level Switch

*Underwriters' Listed for use on oil tanks.*

A float-operated three-terminal switch that can be used to provide high- or low-level alarm, or to start or stop a pump when level rises or falls. It makes possible reliable automatic control in place of gauge glass watching and manual control.



Write for McDonnell Engineering Bulletin ERS-9 which shows typical application of No. 80 on oil storage tanks, complete with wiring diagrams for draining or filling tanks, high- or low-level alarm, signal or cut-off.

***Write for complete literature and engineering bulletins.***

**McDONNELL & MILLER, Inc., 3506 N. Spaulding Ave., Chicago 18, Ill.**

*Doing One Thing Well*

REG. U. S. PAT. OFF.

*Your Jobber Stocks Them*

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## Appointments

Begins on page 226

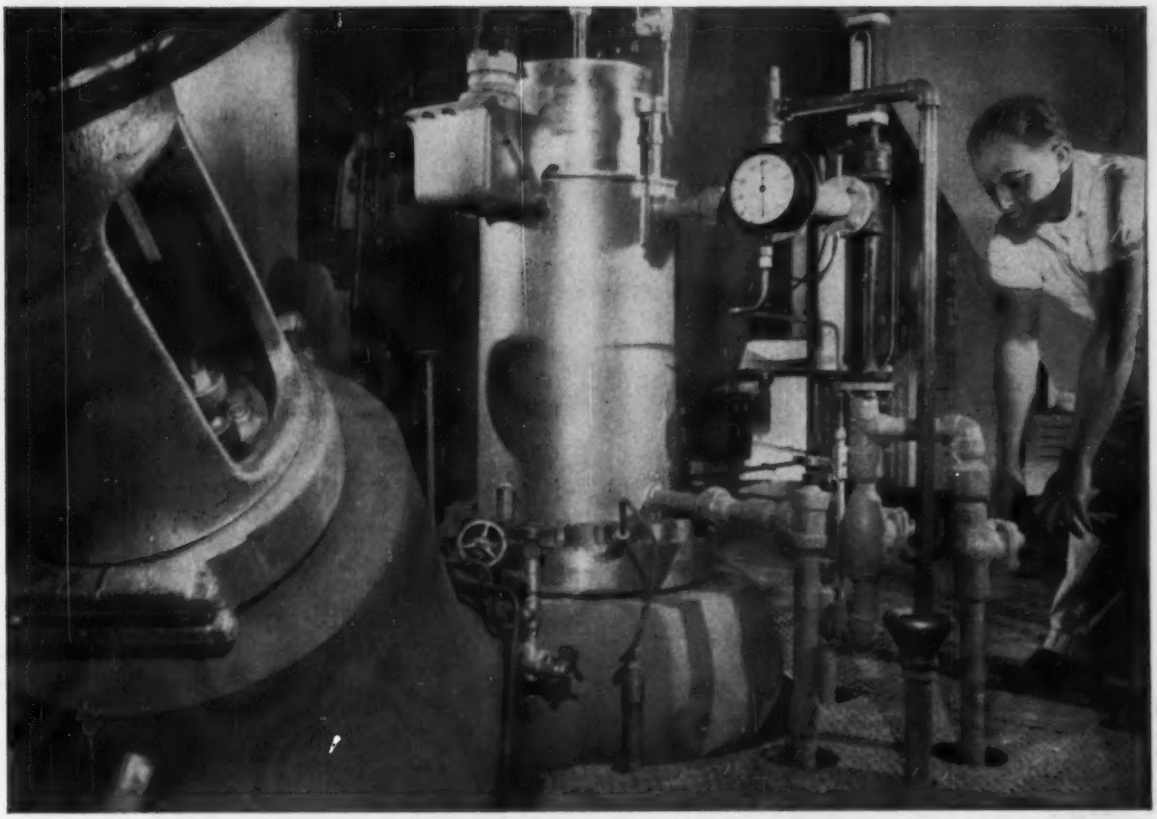
At General Atomic Div, LeClair will play an important role in expanding development of commercial applications for General Dynamic's advanced power-reactor systems.

**American-Standard,** Detroit Controls Div: R L Campbell, director of engineering; G F Butterfield, general manager of manufacturing. **Air Reduction Sales Company:** C H Glasier, executive vice-president. **Appalachian Power Company:** R E Hodges, vice-president and general manager. **Avnet Electronics Corp:** H S Thorpe, general manager. **The Babcock & Wilcox Company:** W H Feldmann, board of directors. **Clarage Fan Company:** R A Wasson, president and general manager.

**Combustion Engineering, Inc:** H M Lowenstein, J L Menson—vice-presidents. **Cohu Electronics, Inc:** W S Ivans, R E Mcdowall—directors. **Cummins Diesel International Ltd:** Dr H Berger, J T Hanou—board of directors. **Endevco Corp:** R R Bouche, manager of standards and analysis dept. **General Electric Company:** J E Phillips, manager of Product Development Laboratory; N H McElroy, board of directors. **Hewitt-Robins Inc:** E B Gardner, executive vice-president.

**I-T-E Circuit Breaker Co,** Kelman Power Circuit Breaker Div: R L Sutherland, plant superintendent; E B Rietz, manager of engineering. **Kaiser Aluminum & Chemical Corp:** J S Urbanik, division manager of plant operations—wire and cable works. **Kennedy Valve Mfg Company:** J R Erven, director. **The Liquidometer Corp:** R T Zwack, manager of industrial products. **Marcus Transformer Co, Inc:** B H Anderson, vice-president.

**Prudential Industries:** O J R Troup, chairman of board. **The Ridge Tool Company:** W L Parcell, executive vice-president. **Stanford Research Institute:** J B Black, S C Beise—board of directors. **Stewart-Warner Ltd:** C W Van Allen, managing director. **Stone**



**This "canned" motor-pump**...comprising a pressure-tight cell that houses stator and rotor (each in sealed "cans") plus impeller...circulates 4700 gpm of 605°F water at 1725 psi continuously in a closed loop system. Units can be built for pumping 5 to 17,000 gpm at pressures up to 2500 psi at 650°F; units for liquid metal, to 1000°F. A development of Atomic Power Div., Westinghouse Electric Corp.

# Pump made leak-proof...needed Inconel

## For steam plants *today*... atomic plants *tomorrow*

THIS IS a "canned" motor-pump. It's completely sealed to circulate coolant in a closed system for as long as 20 years!

**Without maintenance or leakage**

Zero leakage is an essential for nuclear reactors, because their coolants absorb neutrons and become radioactive. Even the *smallest* leak could spell disaster.

**Inconel liner seals stator** from coolant. Another seals rotor. Liquid being pumped can flow between. No external shaft seals. No packing problem.

The canned pump may also prove a great advance for other high-temperature, high-pressure uses.

Basic to its success is Inconel* nickel-chromium alloy. Inconel helped the designers lick the induction-motor-operating problem caused by two metallic walls between stator and rotor.

Making the walls of Inconel—*thin* Inconel—gives them high electrical resistivity. Minimizes current loss. And there's no interference with magnetic fields.

In addition to being non-magnetic, Inconel nickel-chromium alloy provides high strength at 1000°F and above. It resists corrosive attack and stress-corrosion cracking, too.

The canned motor-pump is but one of many examples of why you'll find Huntington Alloy Products in tomorrow's nuclear-energy equipment...and in today's power plants.

Right now, consider *your own* particular problem. Perhaps a high nickel alloy will provide the exact physical, chemical and electrical properties you need. Let us help you find out. Write for our technical bulletin "Engineering Properties of Inconel".

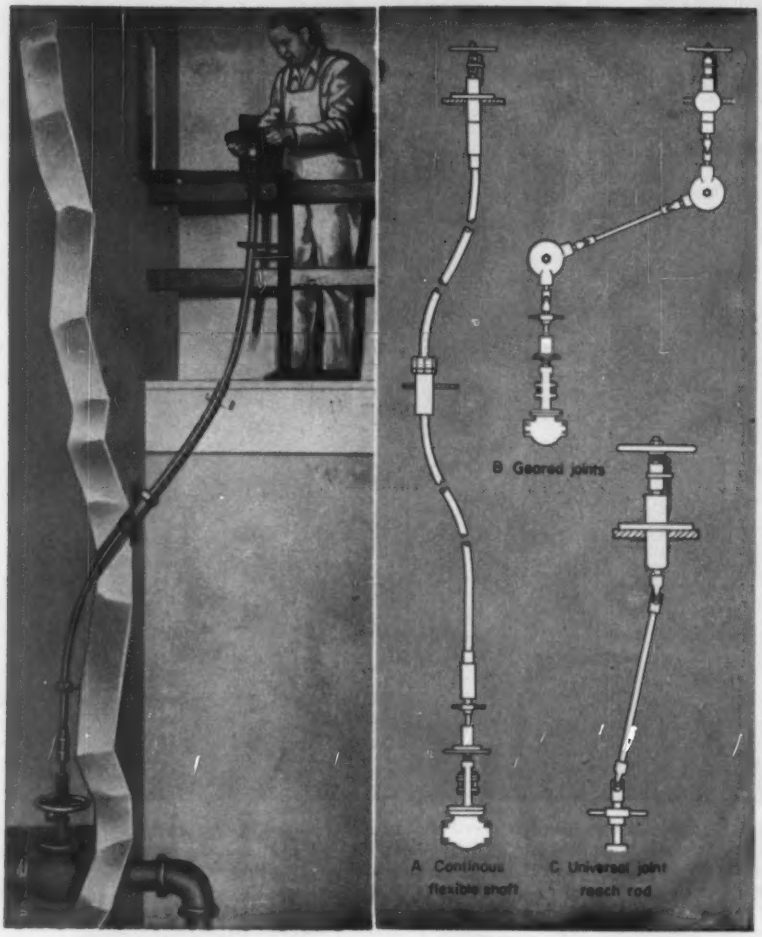
*Inco trademark

**HUNTINGTON ALLOY PRODUCTS DIVISION**
**The International Nickel Company, Inc.**
**67 Wall Street** **New York 5, N.Y.**

# INCONEL®



For more facts circle 358 on Reader Service card, p 133




## Typical station arrangements

# Remote control for valves

In recent years increasing numbers of manual remote controls have been installed in industrial power plants and on nuclear reactors. These systems are popular because they eliminate a great deal of hazardous climbing and permit relatively inexpensive control of a number of widely scattered valves.

Stow Manufacturing Co. makes a complete line of these controls, including: flexible shafting, universal joints and geared joints. These controls also include standard remote stations, intermediate connections and valve couplings for both flexible shafting and reach rods.

Typical installations of this equipment are shown above. Sketch "A" shows a flexible shaft that can be used up to 100 ft. in length and is available in sizes up to 1⅝" diameter. Sketch "B" is an installation using geared joints that operate in any angle through 340°.

For complete design data on all sizes of standard flexible shafts, geared joints and terminals, write for Design Manual 5811.

**STOW MANUFACTURING CO.**
**181 Shear Street, Binghamton, N. Y.**

## Appointments

Begins on page 226

**& Webster Engineering Corp:** T C Williams, chairman of board; F W Argue, executive vice-president. **Thompson Ramo Woolridge Inc,** Tapco Group: C W Chase, product planning manager — electronics. **Tube Turns Plastics, Inc:** E A Erich, vice-president. **Waltham Precision Instrument Company:** F Morse, director. **Foster Wheeler Corp:** W L Martwick, chairman of board; J E Kenney, president and chief executive officer.

## Recent purchases and mergers

**Aluminum Company of America:** purchase of Rea Magnet Wire Company, Inc. **American Boiler Manufacturers Association & Affiliated Industries:** merger with American Boiler and Affiliated Industries. New name of joint industries will be American Boiler Manufacturers Association. **Crane Co:** purchase of business and assets of Swartwout Company; agreement to acquire operating assets of National U. S. Radiator. **American Metal Products Company:** incorporation of Davis Engineering Div as part of its subsidiary, Tube Reducing Corporation. **Waltham Precision Instrument Company:** purchase of Electric Motor Div of Advanced Products Company.

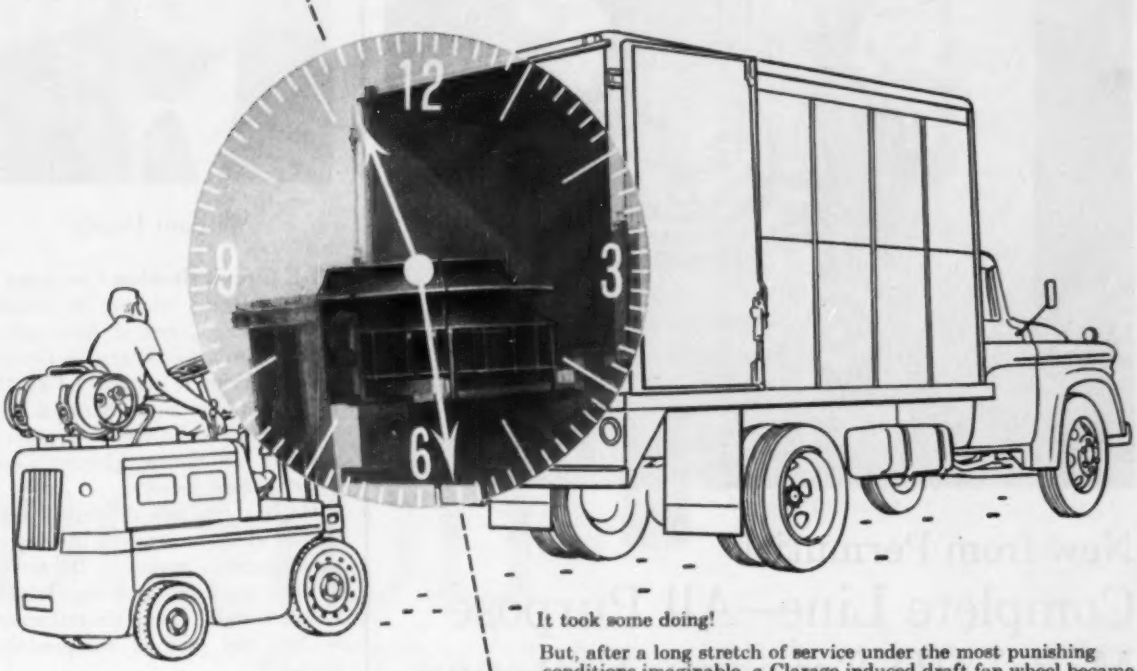
**Belco Div of Bogue Electric Manufacturing Company** has agreed to merge their sales and engineering resources with those of **Head Wrightson & Company Ltd,** England, designers and manufacturers of plant equipment for petroleum, chemical, nuclear and steel industries. Association between the two companies will result in practically world-wide sales and installation of industrial and municipal water-treatment equipment.

Bogue Electric Company's Belco Div has long and specialized experience in automated water treatment, particularly in the power-plant field and in areas of process-water treatment and trade waste disposal.

continued

# CLARAGE

*....exceptional service measured by the customer's clock*




*In just 30 hours this Replacement Fan Wheel was built and on its way!*

**It took some doing!**

But, after a long stretch of service under the most punishing conditions imaginable, a Clarage induced draft fan wheel became worn out by corrosion.

This fan's operation was vital to both the customer and the insurance company whose business interruption policy was in effect. Prompt replacement of the wheel was imperative.

Here, too, it took some doing!

The original hub was returned to Clarage by air at 10 a.m. on Tuesday. Manufacture of the rest of the wheel had already begun. Thirty hours later—at 4 p.m. on Wednesday—a new 1300 pound precision built wheel and 400 pound inlet cone were being loaded at the Clarage plant for delivery to the airport.

Back at the customer's plant a Clarage service representative was ready for the arrival of these replacement parts. His on-the-scene assistance expedited the return to operation of the fan.

Result: another customer (plus an insurance company) impressed by Clarage's all-out service.

*Dependable equipment for making air your servant*

## CLARAGE FAN COMPANY

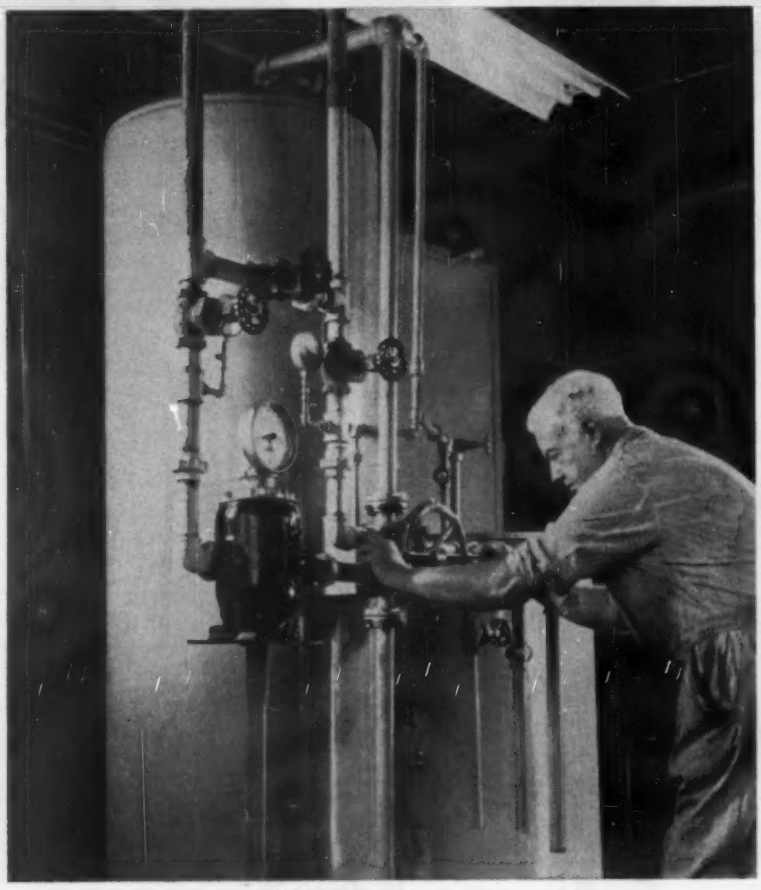
*Kalamazoo, Michigan*

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal



For more facts circle 360 on Reader Service card, p 133

# FLUIDICS* AT WORK



## New from Permutit!®

## Complete Line—All Purpose Model BD Economy Softeners

Permutit Model BD Softeners answer industry's demand for more and more soft water at lower cost. Taking advantage of new design advancements and standardized mass produced components, Model BD Softeners now make Permutit quality available in a complete line, ready for prompt delivery from stock, at economy prices.

BD Softeners contain only high capacity Permutit Q Resin. Absence of subfill eliminates possibility of upsetting bed, makes installation simpler, less expensive. Exclusive double-dish underdrain is shipped completely assembled, further simplifies installation. Standard valve is the famous Permutit Multiport® type.

Permutit Model BD Softeners are available in the following sizes and capacities:

| Shell Diam. | Straight Ht. | Flow Rate Average | Softening Capacity |
|---|---|---|---|
| 30" | 6' | 40 gpm | 510 kgr |
| 36" | 6' | 56 gpm | 750 kgr |
| 42" | 6' | 77 gpm | 1020 kgr |
| 48" | 6' | 100 gpm | 1380 kgr |

For specifications and complete information, write to our Permutit Division, Dept. **PO-40,** 50 West 44th Street, New York 36, N.Y.

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

**PFAUDLER PERMUTIT INC.**

Specialists in FLUIDICS . . . the science of fluid processes


## Appointments

Begins on page 226

## Retirements

**William Deans**

**I-T-E Circuit Breaker Company's** William Deans, pioneer in circuit-breaker design, retired from active service with the company on December 31. Prior to joining I-T-E, Mr Deans had been on the personal staff of Thomas A Edison and general manager of Sundh Electric Company in New Jersey.

He is a graduate of Cornell University where he received the degree of mechanical engineer. He served on the Cornell faculty before joining Edison's staff. Upon his retirement he held the rank of vice-president for I-T-E.

Dean's significant contributions to the electrical industry center primarily in the area of electrical buses and high-voltage bus structures. He also contributed to furthering circuit-breaker art, having pioneered in employing mathematics to predict behavior of natural phenomena.

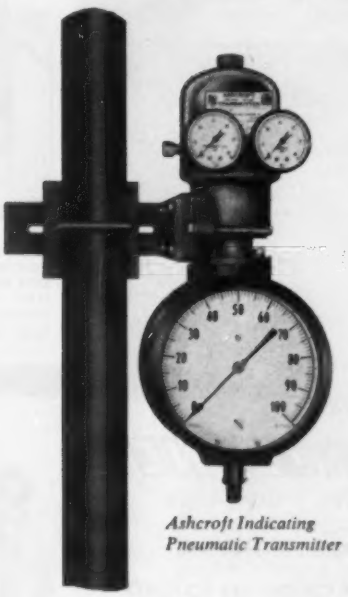
**Elbridge G Dudley,** manager of New York District of General Electric Company's Component & Intermediate Distribution Sales Dept, after 39 years with the company.

**Roland M Gardner,** manager of Equipment Development for Sylvania Lighting Products Div of Sylvania Electric Products, Inc, after 41 years.

continued

# signal

**ASHCROFT PNEUMATIC TRANSMITTERS give you a true primary and transmitted signal for indication or control**



*Ashcroft Indicating Pneumatic Transmitter*

# action

Now—detect with precision accuracy the slightest change in primary pressure or temperature. Transmit this signal quickly to your indicators or controllers. Ashcroft Pneumatic Transmitters achieve these results for you at the lowest initial and operating costs.

Full-range, solid-front indicating and totally accessible nonindicating transmitters eliminate the need for costly high pressure lines, yet permit complete monitoring of process conditions in remote areas.

Narrow-span Ashcroft Transmitters are expressly designed with highest sensitivity and repeatability for the most accurate primary signal feed to controllers. You get better control and purer, lower-cost final products.

Only in Ashcroft Pneumatic Transmitters can you get the wide choice of Ashcroft Duragauge Bourdon tubes or American mercury or gas-actuated systems for sensing pressure or temperature conditions. You also get a time-proven, obstruction-proof, force-balance, nonbleed relay for economical, maintenance-free 3-15 psi or 3-27 psi signal transmission.

Write for factful Bulletins 360 and 361 or ask your nearby Ashcroft Distributor to help you select the right transmitters and receiver gauges for your specific requirements.

MANNING MAXWELL & MOORE INC. MM&M TRADE MARK

***ASHCROFT PNEUMATIC TRANSMITTERS***

***A product of***

**MANNING, MAXWELL & MOORE, INC.**

*Consolidated Ashcroft Hancock Division • Stratford, Connecticut*
*In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*



**For more facts circle 362 on Reader Service card, p 133**

ARGONNE NATIONAL LABORATORY

WILL USE...

Containment shell of the experimental breeder reactor under construction in Idaho and (above) cut-away showing reactor vessel within the "primary tank."

ELECTRODYNE®

AUTOMATIC VALVE CONTROLS

FOR EXPERIMENTAL

BREEDER REACTOR IN IDAHO

*Electrodyne* will be used by the Argonne National Laboratory as the control for the reactor vessel cover hold-down mechanism in the new experimental breeder reactor EBR II at the National Reactor Testing Station near Idaho Falls, Idaho.

EBR II is a "closed cycle" power plant, where nuclear fuel will be employed to produce heat and at the same time make additional fuel by a "breeding" process. The partly spent fuel and the new fuel that has been bred can then be reprocessed and refabricated into new fuel elements right in the EBR II facility.

*Electrodyne* is an integral part of the EBR II design controlling the hold-down mechanism for the cover of the fuel chamber which will be submerged in liquid sodium. This reactor has been planned to demonstrate the "breeding principle" that more fuel (plutonium) can be bred from uranium-238 than is used up while the reactor is operating. EBR II has been designed to produce usable electricity from atomic energy.

For customer applications, *Electrodyne* thrust limiting features assure positive, automatic control and complete safety in the handling of the most critical materials.

This again illustrates the versatility of *Electrodyne* as a valve-type control for a wide variety of applications in chemical and power plants, oil and gas industries and water and waste treatment installations.

For detailed information about *Electrodyne*, get in touch with your local *Electrodyne* representative or any valve manufacturer.

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ELECTRODYNE VALVE CONTROLS . . . HYDROID GEAR PUMPS AND MOTORS . . . PRECISION INDUSTRIAL, AIRCRAFT AND MISSILE BEARING AND COMPONENTS


## Appointments

Begins on page 226

**Frank M Ryan,** vice-president and general manager of Norton International, Inc, after 46 years with the company.

## Obituaries

### H W B Skinner

**European Organization for Nuclear Research** (CERN) announces the sudden death in Geneva on Jan 20 of Professor H W B Skinner, Head of the Dept of Physics, Liverpool University, United Kingdom.

Professor Skinner was born in England in 1900. He attended Trinity College, Cambridge and carried on research in physics at Cavendish Laboratory, Cambridge from 1922 to 1927. After a long career in physical research in the U.S. and England, he was appointed Head of the General Physics Div of the Atomic Energy Research Establishment in 1946 where he remained until he was appointed a Lyon Jones Professor of Physics at Liverpool Univ in 1949.

Professor Skinner played an outstanding role in the development of CERN. He was chief consultant in designing and building Cern's 600-million electron volt synchro-cyclotron. At the time of his death he was taking part in a meeting of European physicists to discuss the future experimental-research program of CERN's 25-thousand-millon electron volt proton synchrotron.

**Everett E George,** former electrical engineer with Ebasco Services, Inc, at the age of 67.

**A De Groot,** electrical contractor and state treasurer of National Association of Power Engineers, on February 23. He was 66.

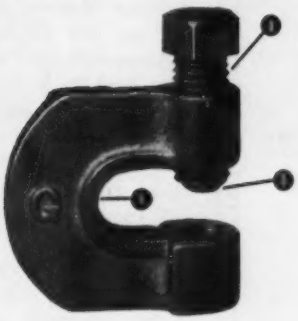
**Richard T Jeffery,** municipal engineer and consultant for Hydro-Electric Power Commission of Ontario, on February 8.

**J Leo Welch,** vice-president in charge of operations of Niagara Mohawk Power Corporation, on February 10. He was 67.



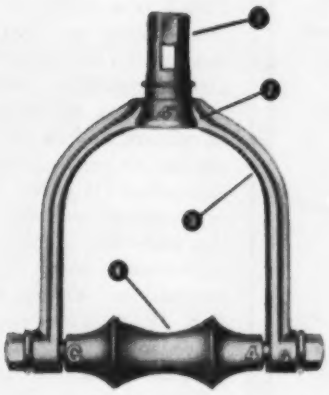
For more facts circle 363 on Reader Service card, p 133

# Look at all the extras you get in Grinnell Pipe Hangers . . . yet you pay no more!



**GRINNELL C-CLAMP, FIG. 88 — 1** Ribbed, malleable iron casting, for extra strength **2** Hardened steel, cup-point set screw for good "grip" on beam **3** Full thread engagement – casting is drilled and tapped for rod and set screw

**GRINNELL EXTENSION SPLIT RING, FIG. 138 — 1** Nipple engaging thick section of malleable iron gives rigidity for support from above, below or from wall **2** Tapped to take screw. No nut to lose **3** Special ring contour holds pipe or tubing firmly



**GRINNELL ADJUSTABLE SWIVEL PIPE ROLL, FIG. 174 — 1** Swivel shank permits adjustment without elaborate support **2** Locking device prevents accidental adjustment change; no lock nut required **3** Ribbed design in malleable iron for better strength, lightness, appearance **4** Easy installation; maximum adjustment

**GRINNELL CB CONCRETE INSERT, FIG. 282 — 1** One body size accommodates several sizes of rods **2** Slot takes reinforcing rods to assure maximum load rating **3** One-piece body prevents concrete seepage **4** Teeth on insert and nut hold rod firmly in place **5** Homogeneous composition of malleable iron throughout

You get *more* hanger for the money from Grinnell, because Grinnell's huge volume reduces production costs . . . lowers prices right into line with competitive hangers offering less.

Yet you get *so much more* . . . wider choice of types and sizes; better quality control; published ratings for *all* hangers; faster delivery from warehouses nationwide; and more responsible field service by trained Grinnell personnel . . . regardless of how far from the job site the sale was made! Grinnell Company, 277 West Exchange St., Providence 1, R. I. Branch Warehouses in Principal Cities.

*Remember, The Best Costs No More — from America's #1 Supplier of Pipe Hangers and Supports*

Call your local Grinnell Distributor for pipe hangers, cast and malleable iron fittings, malleable unions, steel nipples – all made by **GRINNELL**



For more facts circle 364 on Reader Service card, p 133

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# Bookshelf

**Theory and Design of Small Induction Motors.** *By C G Veinott. 540 pp, 334 illust, tables. $13.50. McGraw-Hill Book Co, 330 W 42 St, New York 36, N. Y.*

Author of this book is a long-established authority on small electric motors, as readers of his classic *Fractional Horsepower Electric Motors* well know. The new book is written primarily as an introduction to theory and design of induction motors. However, treatment is intended to be sufficiently comprehensive to let an engineer make practicable designs by following the procedures described. Contents of the book were developed by teaching study groups and classes of graduate engineers.

Subject is taken up in four parts. Part I is a broad survey. Part II treats theory and performance calculations for both polyphase and single-phase motors. Calculating tools are discussed, including use of desk calculators, and an entire chapter is devoted to use of computers in design. Part III covers evaluation of basic motor constants. It provides the basis for prediction of motor performance from known machine geometry and winding specifications. Part IV discusses practical design procedures, giving various ways to determine machine geometry and winding specs to obtain desired results.

In his discussion of single-phase induction-motor theory (Part I), author doesn't advance any new rotating-field theory, but discusses the two traditional approaches: cross-field and revolving-field theory.

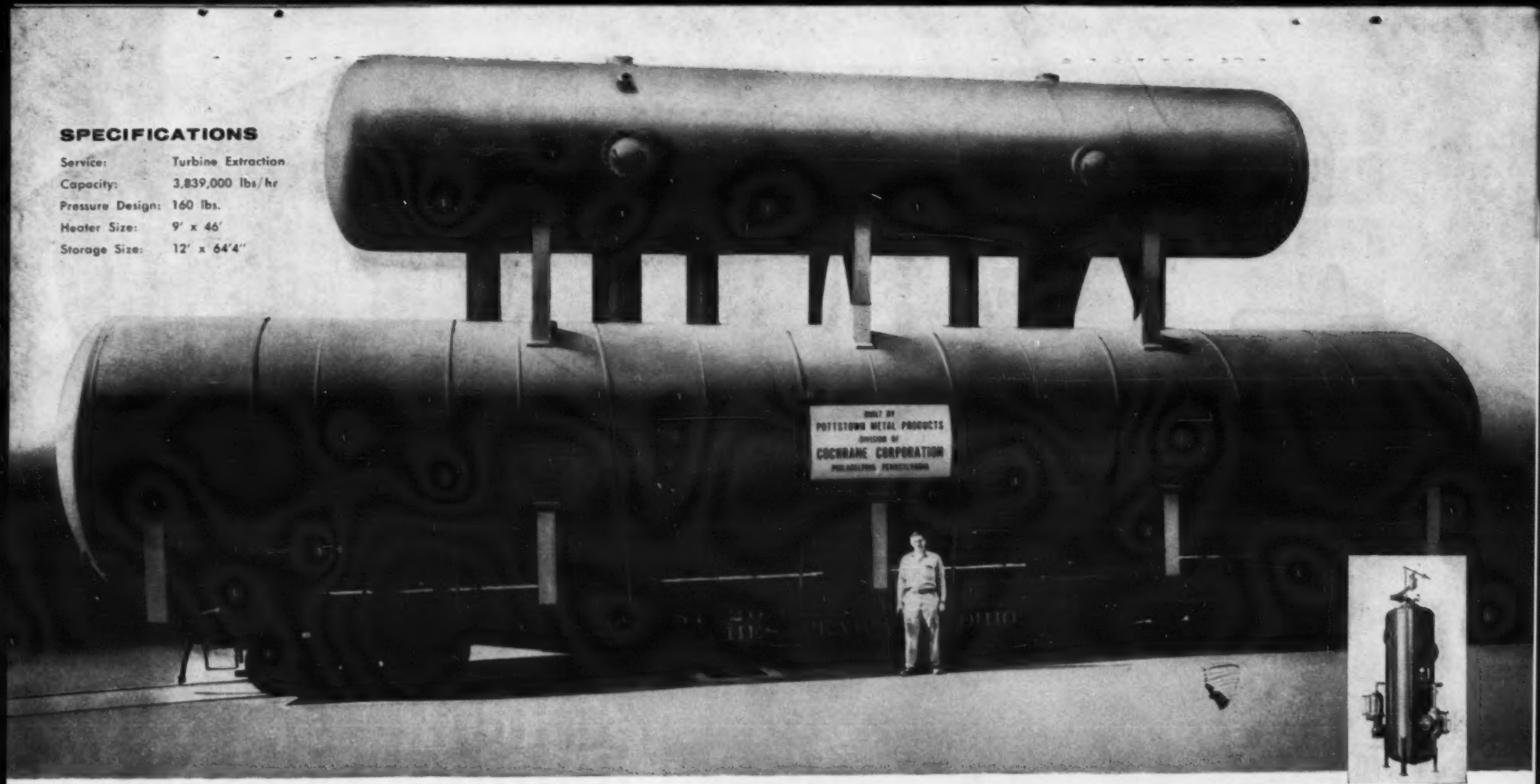
---

**650-mw nuclear power station** estimated at 170 to 180 million dollars will be built at Sizewell, Suffolk, England. Completion is slated for 1965.

**Arched dams** for hydro projects are gaining on straight-dam types, according to Soviet construction magazine. Three new arched dams are now being built in U.S.S.R.



circle 366 on Reader Service card, p 133 ➤




**SPECIFICATIONS**

| | |
|---|---|
| Service: | Turbine Extraction |
| Capacity: | 3,839,000 lbs/hr |
| Pressure Design: | 160 lbs. |
| Heater Size: | 9' x 46' |
| Storage Size: | 12' x 64'4" |



**MIDGETS OR GIANTS**

From the giant deaerator with its 12' x 64'4" storage tank above down to a 3' x 8' Unipac standard model, shown in comparable size in inset, there is no compromise in Cochrane's engineering and fabricating standards.

# It took 96 years to build this Giant Deaerating Heater!

Ordered April 1958, delivered May 1959, the engineering background that made possible the design and fabrication of this gigantic unit has kept Cochrane foremost in its field for 96 years.

This 3,839,000 lbs/hr deaerator is designed for turbine extraction service in a public utility. An important contract requirement was an integrated tank shop capable of fabricating the shells to rigid specifications.

Cochrane pioneered in heater design and manufacture and today has the largest number of installations in the world. This background is your assurance that *guarantees will be met.*

Your requirements in deaerators, whether a small standard model or giant, can be solved readily by calling in a Cochrane engineer. Why not write today for the deaerator series bulletins . . . please specify the type in which you are interested.

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**CORPORATION**
3106 N. 17th Street, Philadelphia 32, Pa.
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Representatives in 36 principal cities in U.S.: also Havana, Cuba; Paris, France; La Spezia, Italy; Mexico City, Mexico; Caracas, Venezuela; Santiago, Chile; Honolulu, Hawaii.

**POTTSTOWN METAL PRODUCTS DIV.**—Custom built carbon steel and alloy products.

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George Edwards

## Suggests: a baker's dozen pays off

In Pittsburgh a few weeks ago, I dropped in to visit with an old buddy of mine, Sam Miller. Right after the war, Sam saw the handwriting on the wall and got into the plastics business. Today he's got a small but thriving extrusion plant and is doing all right for himself.

Every time Sam and I get together, we lunch at a spot that dishes up the best ham hocks and sauerkraut this side of heaven. Just as we were leaving his office, the phone rang. "Long distance," said his secretary; "Mr Mulhern in Philadelphia."

Sam's face beamed as he picked up the phone and boomed, "Hello, Eddie, how are you?" into it.

I gathered that whoever "Eddie" was, Sam hadn't seen him for quite a while, was mighty glad to hear from him, and would be happy to take care of what Eddie had called and asked him to do.

At lunch, Sam told me the story, and it's one I think a good many young fellows could profit by. Eddie Mulhern was fresh out of high school the morning he showed up in Sam's office in answer to a want ad Sam had run asking for inexperienced help.

"The kid had barely told me his name," said Sam, "before he picked up a piece of paper from the floor and put it in the wastebasket. I'd thrown it at the can —and missed—half an hour before."

Impressed by this, and the boy's general appearance, Sam hired him. Eddie's job that summer was keeping the blender crews supplied with materials and helping clean the machines. But when he was ahead of his own job, he'd be off giving somebody else a hand. He never wasted a minute, and every guy in the shop had a good word for him.

As the summer wore on, Sam learned that Eddie's father wasn't exactly well-heeled, couldn't give him much financial help toward a college education. But he sure gave him the right slant on how to get along in life. "Education is important," his father had said, "but not as important as *integrity*. If you can possibly help it, never let a single day go by without doing *something extra* that'll make you stand out from the people around you. Give a little more than you're expected to without wanting a pat on the back for it."

And that was exactly how Eddie worked for Sam for a little over a year. By this time, Sam had moved him into purchasing and Eddie was giving it even more of the "something extra." Then came a chance for Eddie to move to a steel-mill job at more money than Sam could afford to pay him. "Can I come back if it doesn't work out?" asked Eddie. "I'll *make* room for you," Sam had replied.

Eddie went to the steel mill, did the same bangup job, made the same impression on everybody who knew him. Then came Korea. Eddie came through without a scratch and took advantage of the GI Bill to get the college education he'd wanted so badly.

He worked at the steel mill during summers, waited on tables at school, still found time to drop in on Sam every now and then. Still giving the "something extra," he graduated cum laude. "A terrific guy," said Sam, as we walked back to his office. "His outlook will take him to the top, and it looks like he's on the way now."

"The phone call?" I asked. "Yeah," Sam smiled, "Eddie's apparently an electronics sharpie. Has a chance to fill a slot at Cape Canaveral. He wanted to know if he could take the liberty of using me as a character reference."

circle 367 on Reader Service card, p 133▶

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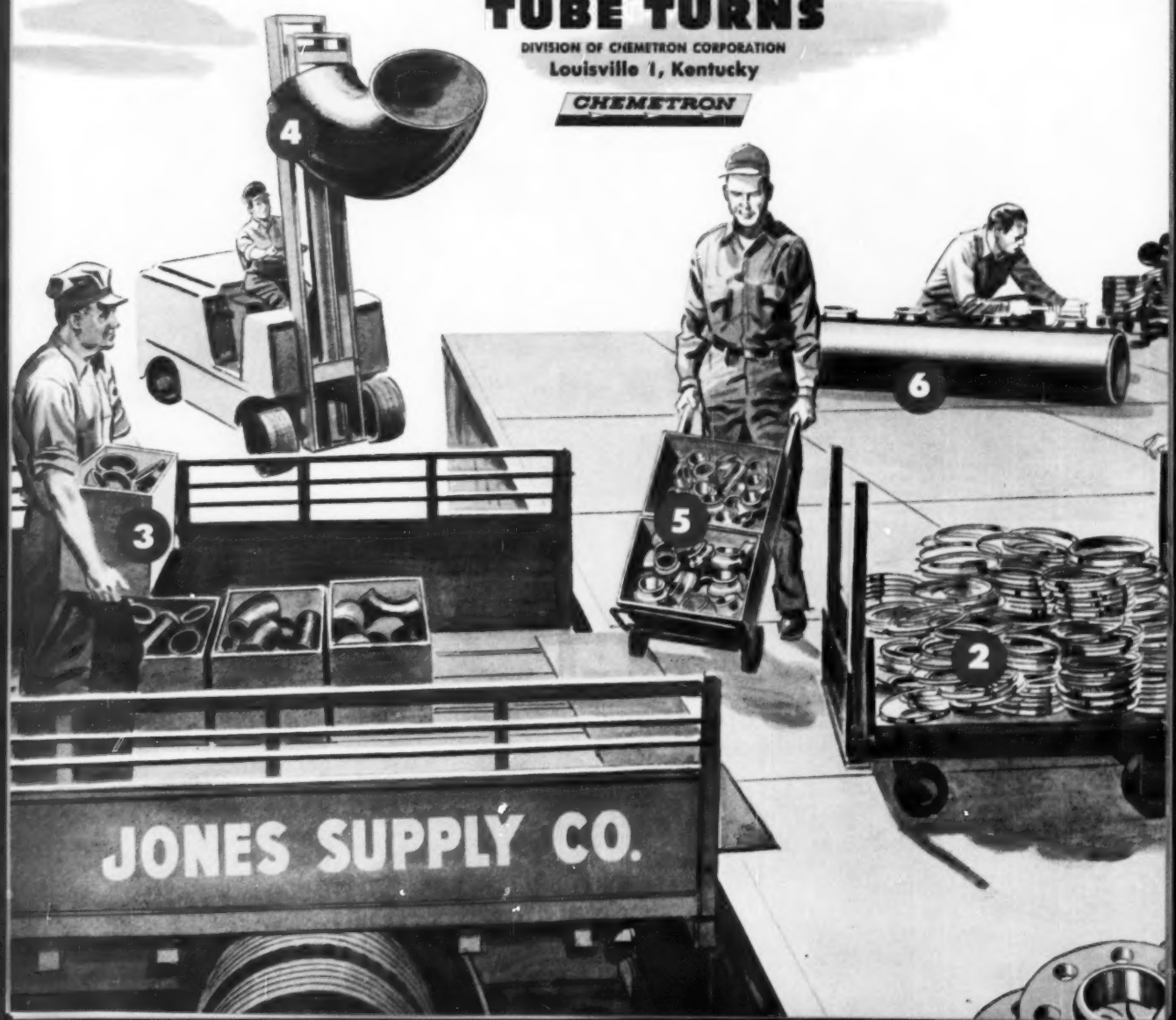

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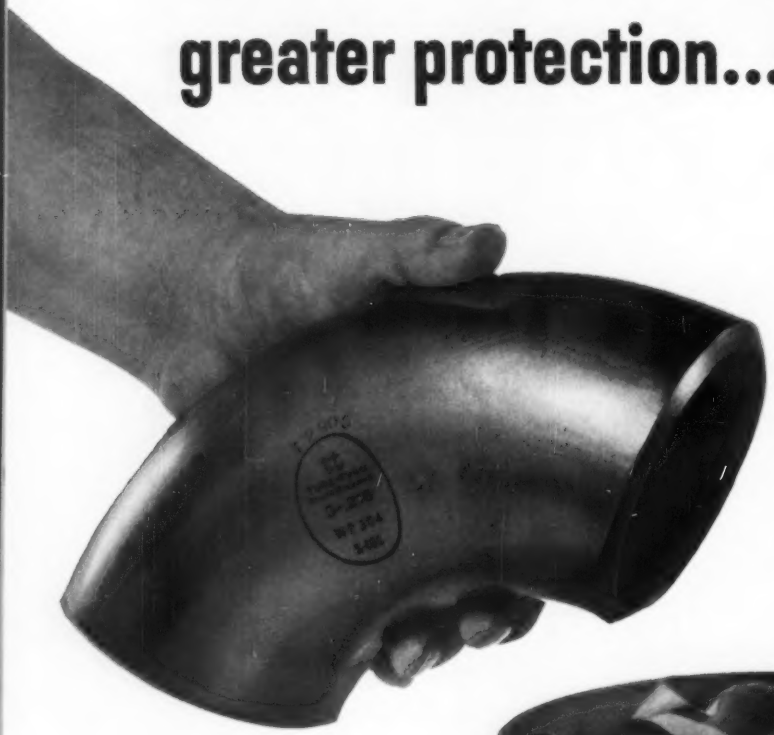

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STEVE ELONKA
Associate Editor in Charge

1 Advanced training for design engineers

2 Simulators for breaking in operating and maintenance crews

3 Better training manuals for instrument mechanics

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# Management's new programs for training instrument personnel

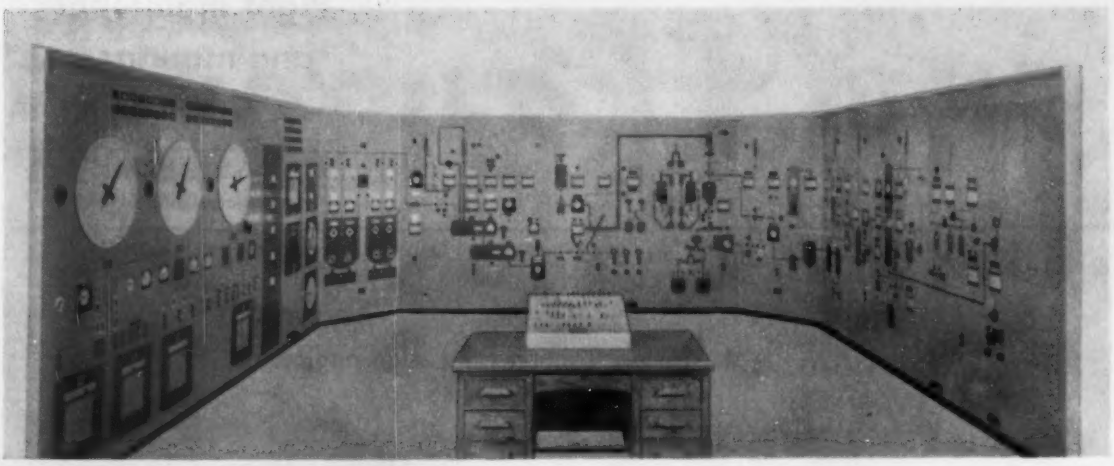
By L E STEWART
Associate Editor

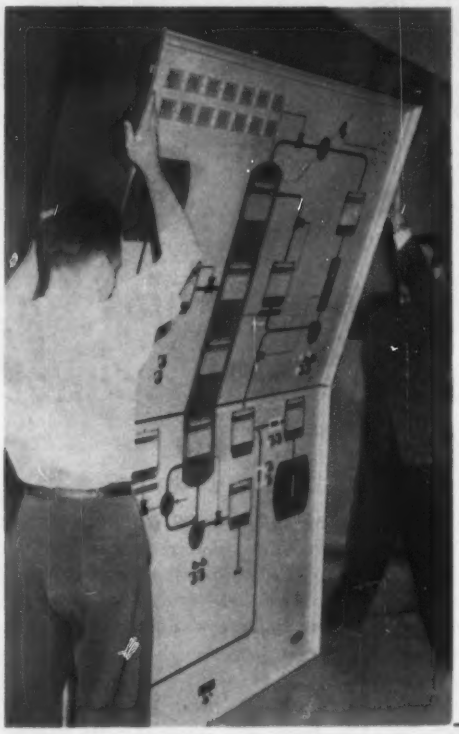
Today's management foresees great changes in personnel requirements for tomorrow's instrumentation. To meet this challenge, management in medium to large industrial enterprises is preparing extensive training programs aimed at supplying tomorrow's needs for instrument-system designers, operating and maintenance crews. In this article, POWER surveys some current plans of management in highly instrumented process industries. You may incorporate them in your own program or modify to suit your special needs.

**Management's function** determines its attitude toward instrumentation as well as toward all other elements of business, and determines its attitude toward personnel—including instrumentation specialists. In the industrial system, management's job is the direction of total business effort to produce some wanted profit pattern. Management does not recognize instrumentation in the same way that an instrument engineer tends to. Management thinks, not of instrumentation as an entity, but of an instrumented plant.

**Instrumentation** improves profits. It pays its own way. Yet sometimes instrumentation is installed which does not develop its full potential because it isn't kept working, pointing to a need for improved maintenance and operational training. Once in a while you find an installation which actually operates better on manual than on automatic control, pointing to a need for better understanding of process conditions and dynamics. To realize instrumentation's potential and answer these needs will require careful personnel planning. New levels of training are required in these areas of design, operation and maintenance. To see what can be done, let's look at three working programs described at recent technical conferences.

continued





## Training on process simulator shortens operator's shakedown time in real plant

Trainer, above, manufactured by Carmody Corp, duplicates in every respect complete central control panel for chemical plant. Instructor's console is in center. All instruments, symbols, alarms and recorders appear on a 1:1 scale just as on actual panel. Crews were trained and operators ready to put plant equipment on stream as soon as plant was completed. Instrument mechanics were familiar with location of equipment and ready to maintain it.

Success of training program prompted same company to order portable unit, left, for demonstrations to management and operating personnel in scattered plants. Where basically standard control panels are used in several plants portable unit supplies valuable training while giving maximum mileage from investment in simulators. Unit shown folds to oversized suitcase which easily moves from one plant to another. Standard building blocks of complete control panel could be rearranged to simulate new panel.

### 1 Training design engineers

Training engineers for tomorrow's instrumentation demands a new approach. Expanded use of the systems-engineering concept will require experienced process engineers with training in mathematical methods of dynamic systems analysis and synthesis. To meet this need, 3½ years ago, Monsanto Chemical Company established a special company-sponsored educational program. This was a full-time academic-leave program designed to produce a core of process engineers skilled in fundamentals of systems engineering applied to process studies. Course was organized by St. Louis University in cooperation with Monsanto engineers. Except for courses dealing with special aspects of process dynamics, chemical engineering and chemical kinetics, all courses were standard university presentations delivered by faculty.

**Background courses** and refreshers occupied 11-week summer session, designed to provide uniform background for the graduate chemical, electrical and mechanical engineers. All students followed through with 2-semester program covering basic servomechanisms, a special course in analog and digital computers, complex-function theory, operational mathematics, advanced

servomechanisms, a special servomechanisms course related to process dynamics, and chemical engineering.

Following academic part of program, students spent three to four months of experimental work in Monsanto research labs. They worked on a Master's thesis, also made valuable transition from academic atmosphere to that of industry.

Monsanto management considers this program a first step toward providing the type of design engineer needed for tomorrow's problems.

## 2 Process-simulator training

Training on simulator attacks major operational problem of the man-machine relationship, and underlying problem of how best to transmit information to maintenance crews and operators about the process itself—and get the most out of equipment by having them use this info correctly. Simulator places operator in a training situation which physically duplicates operational environment in which he works. Instruments and controls are activated, many from instructor's console. Simulator sets up normal and emergency situations likely to arise, and operator must respond and perform as he would on the job. Simulator fills role in lecture and demonstration as well as training through manual practice.

**Three important advantages** stemming from use of this device are: (1) "Learning by guided doing." Instructor passes info on to the trainee who performs on simulated equipment. This forces trainee to take an active part in learning by performing actions directly transferable to the actual control panel.

(2) Duplicating operating situations gives your man training and practice in using his judgment—the critical role of humans in automated man - machine systems. Simulator-trained judgment can be a prime factor in determining qualification for the operator's crew and upgrading.

(3) This training tool permits emotional conditioning. Sometimes we depreciate or fail to understand how important this is. Company makes a major capital investment in new equipment. Trainees are unaccustomed to the new process, but feel that any damage to equipment or product spoilage jeopardizes them. Unwillingness to expose their lack of information is only a natural reaction, particularly in older operators. And so when fear is coupled with lack of knowledge, training is slow. Simulator provides critical operating conditions and guided practice with complete safety, free from danger of damaging equipment or spoiling product.

## 3 Better maintenance training

Management foresees an increase in number of maintenance men required. They also foresee a need for improved training of mechanics. Training in dexterity and knowledge of how each instrument should be repaired and adjusted can be handled by classroom and workshop instruction. More difficult to achieve by instruction is the ability to diagnose a situation to determine where trouble is located in a process system.

Finding no ready-made instrument-maintenance training completely satisfactory, Monsanto Chemical Company developed an instrument maintenance course designed for both mechanics and maintenance engineers. Their basic course in instrument repair runs 12 weeks of five 8-hr days each.

**Text is special,** prepared from the maintenance, not the design viewpoint by experienced maintenance engineers. It has one objective—to teach work which an instrument repairman is required to do. Unlike courses usually offered by instrument companies, this one seeks to teach principles rather than repair and adjustment of specific makes of instruments. However, these are principles of instrument repair and adjustment rather than basic theory of instrumentation.

**Curriculum** is strictly functional, organized to duplicate repair problems encountered on the job as well as can be done in a laboratory. Standard commercial devices are selected to illustrate each problem, and operation, adjustment and repair principles are related to them. No attempt is made to teach design or even application of the devices except as applied to trouble analysis.

Second feature of repairman's training program is preparation of standard instrument - maintenance outlines. Each outline covers a specific make and model of component. Outlines are based on instructions prepared by manufacturer, rewritten where necessary by Monsanto maintenance engineers and tested by repairmen in the field. They are precisely outlines, listing every step needed to maintain and adjust instrument. Prepared in this way, they present procedures made uniform from manufacturer to manufacturer and from instrument to instrument, written in the language of the repairman and the basic repair course.

As tomorrow's instrumentation calls for more extensive programs, the basic training afforded by Monsanto's course can easily expand to cover the new technologies involved.

**Management's overall view** holds instrumentation as a means to the end of greater profits for less business effort, believing that instrumentation can be applied properly to processes to make great savings. New and better instrumentation will be required and developed. Management suspects that this instrumentation will be more complex and account for a greater percentage of physical plant. However, usefulness could be limited by industry's inability to install and service new systems.

You will need to start analyzing personnel requirements for coming years, and start providing for them now. The needs are many, including numbers of people, their proper organization and employment, and the way in which they will carry out their jobs: job classifications, union relationships, training and education.

**Most important** is training and education. Because the problem is somewhat special within an industry rather than of general application, it is imperative that you take the initiative now in educating for tomorrow so that your plant may be designed, operated and maintained by personnel with up-to-date training.

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For details of Monsanto Chemical Co's training program, see paper delivered by C L Parish at ISA Conference, Chicago, Sept 21-25, 1959. Also, additional information on the training simulators may be found in ASME paper 59-A-218 by E O Carmody of Carmody Corp and F L Lichtenfels of Standard Oil Co of Ohio, delivered at the Annual Meeting, Atlantic City, N. J., Nov 29-Dec 4, 1959.

OPERATORS' NOTEBOOK **138**

# Now, a valveless gravity

Today a prime target for many design engineers is doing away with hand operation and downtime of power-systems equipment. One example is shot-cleaning boilers (*Operator's notebook* No. 135, Jan 1960), another is cleaning condenser tubes with rubber balls (*Notebook* No. 137, March 1960). Boilers and condensers can be cleaned in operation without disturbing output.

Now, we have a completely automatic gravity filter for industrial plants using process and potable water. Manufactured by The Permutit Co, it has no valves—needs no attention in operation. No doubt this filter is a harbinger of a whole slew of simply constructed, automatic equipment. It filters, then backwashes itself, at exactly the right time, working on loss-of-head principle.

**Construction.** Filter is a vertical steel tank, divided into three sections: backwash-storage space, filter-bed compartment and collector chamber under a false bottom.

Backwash-storage space holds the optimum amount of backwash water for filter-bed area. Because this space always fills to the same height it always assures a uniform backwash water volume.

**How it operates.** Water from a coagulator or some other constant-level source enters filter-bed compartment just above the bed. It flows downward through the sand and plastic strainers into the collector chamber, then upward through the effluent duct and out to service.

As the filter bed collects dirt during the filter run, head loss naturally increases. That causes water level to rise slowly in inlet and backwash pipes. Just before the water passes over into the downward section of the backwash pipe, a self-actuated primer system evacuates air from the backwash pipe. This pulls water rapidly over into the pipe, causes a large volume of water to flow down the backwash pipe and start the siphon action that backwashes the filter.

**Backwashing.** Backwash pipe carries about six times as much water as the inlet pipe. This reduces the pressure immediately above the sand bed and draws water from the backwash-storage space down through the ducts and upward through the strainers. Upward action expands the sand bed and cleans it, discharge going to waste. Then backwash storage level drops below the end of the siphon breaker. This admits air to the top of the backwash pipe, stopping the backwashing.

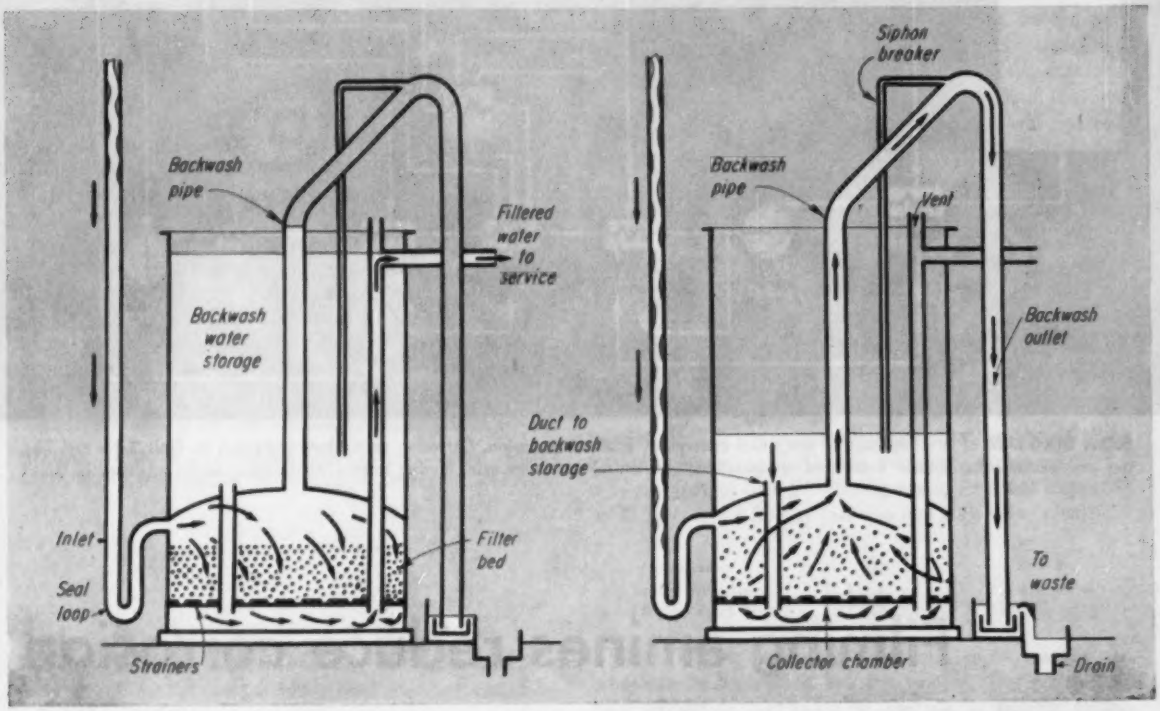
Inlet water then continues its downward gravity flow, automatically rinsing the bed. Rinse water flows up into the backwash-storage space where it is saved for the next backwash. Once it reaches outlet level it goes no higher; all filtered water flows to service.

**WORKING AWAY** automatically, day and night, these filters have no pumps, valves, instruments. They're untouched by hands

**Advantages.** Manpower, instrumentation and auxiliaries aren't needed with these automatic valveless gravity filters. Because there are no valves to operate, gages to watch or pumps to start and stop, man-hours are

# filter that's completely automatic

By STEVE ELONKA, Associate Editor




**FILTERING** gradually clogs filter bed with dirt, increases head loss, raises water level slowly in inlet and backwash pipe

**BACKWASHING** starts when water rises to top of backwash pipe and overflows, causing siphon action to reverse flow through unit

eliminated. No rotary wash is needed because unit can operate only to a 4- to 5-ft head loss.

Entire operation takes place hydraulically and flow direction is changed by atmospheric pressure so no valves are needed. No mechanical, air-operated or hydraulically operated device is needed; the unit filters whatever volume is delivered to it.

No rate-of-flow indicators are needed as the plant inlet flow is divided evenly among the units. Rate of each unit can easily be calculated from the plant inlet meter —just divide by the number of filters in operation.

No loss-of-head indicator is required. Elevation of water in the backwash pipe represents loss of head so unit is its own indicator. Since the unit washes whenever head loss reaches the proper point, loss-of-head information is not really needed.

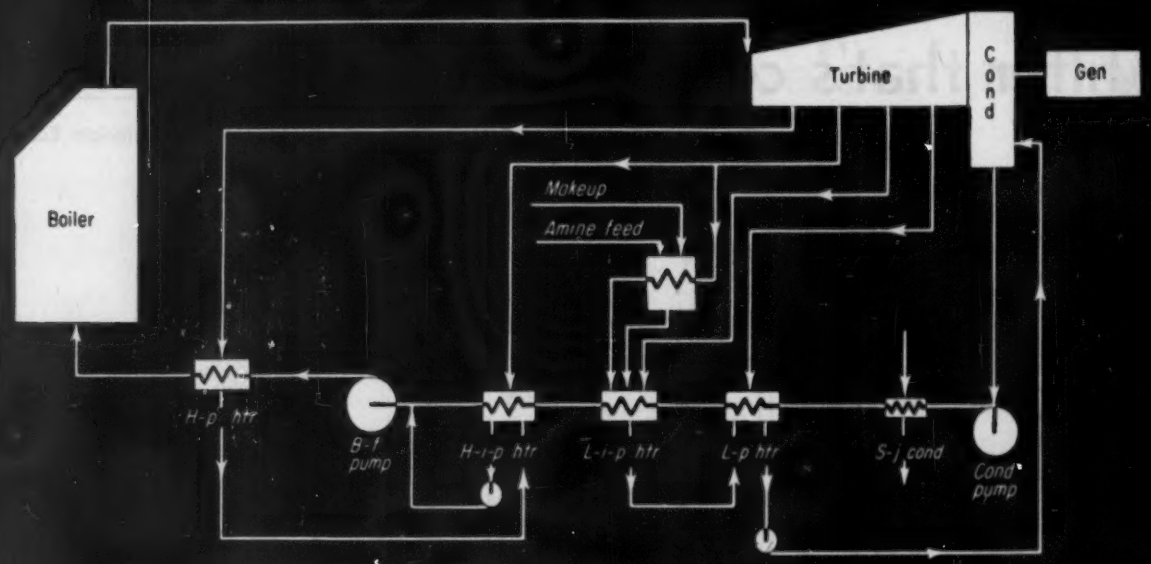
No mechanical, air-operated, or hydraulically operated backwash-rate controller is needed because a backwash regulator is designed into the unit. Adjustment is made only at the time of installation. And because the backwash regulator insures the proper rate, no backwash-rate indicator is needed. No wash pump is needed for filter operation as the backwash water is always stored in the unit at the proper elevation.

As for operating tables—there is nothing to operate so why have tables? And because all operations are controlled by the unit itself, no electricity, instrument air or pressure water is needed. You can forget maintenance because there are no moving parts. Of course, to keep unit sparkling it should be painted along with your other equipment.

**Backwash rate** is controlled by the size of the backwash pipe. Finer adjustment is made by means of a backwash regulator at the outlet end of the backwash pipe. This regulator is positioned to control the opening and thus the flow. But it's bolted to the proper position when filter is installed, need not be changed.

While the backwash rate averages about 15 gpm per sq ft of bed, rate is not uniform over entire period. As the backwash-water level drops, rate diminishes. Backwash rate really starts at about 20 gpm per sq ft and gradually slows to 10 gpm per sq ft at the end. It has been found that this diminishing backwash rate is more efficient than a uniform flow rate. A higher initial flow quickly lifts and expands the bed about 50%, providing initial turbulence to wash the sand. It has also been found that the lower flow at end of wash hydraulically grades the sand and settles the bed evenly and smoothly.

Upset beds are no problem. Unit doesn't use any gravel; only fine filter sand is needed. Because a negative head cannot develop, primary cause of cracked beds, channeling and mudballs is completely eliminated.




**FLOW DIAGRAM** of two duplicate 60-mw steam generators. Filming and neutralizing amines were used comparatively to control corrosion. Corrosion rates show reduction in Unit 2 l-p and l-i-p heaters using filming amines; neutralizing amine was used in Unit 1

# Filming amines reduce corrosion

**Duplicate 60-mw units operating side by side offer unique way to compare various amine-treatment schemes. Test results show reduced corrosion rates and improved heat-transfer coefficients with continuous filming-amine treatment**

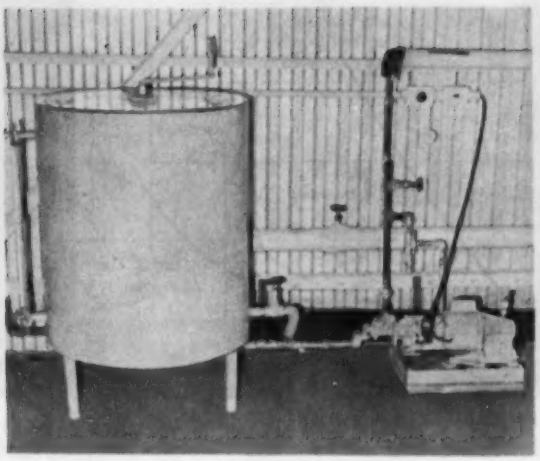
By J P WHITE, Arkansas Power & Light Company

Two duplicate units, operating side by side in the Arkansas Power and Light system, offered a unique means of directly comparing effectiveness of filming- and neutralizing-amine treatments. Increased iron oxide in the feedwater and corrosion in the low-pressure-heater drain lines of both cycles prompted the studies.

**Generating units** are 1250-psig 950-F closed-cycle type. They've operated for about eight years. Boiler makeup is clarified river water, softened by sodium-zeolite ion-exchange method and evaporated. Evaporator vapor comes in at the low-intermediate-pressure heater. Bicarbonate alkalinity to the evaporator is 80 ppm and vapor to the cycle contains 30-ppm $CO_2$. With venting on the low-intermediate-pressure and low-pressure heaters, the drips from each heater had a relatively low pH of 6.7.

After three years' service it was necessary to replace the steam-jet vacuum pump after-condenser tubes. Tube leaks in the low-pressure heaters became a problem and it was also necessary to replace entire low-intermediate-pressure heater drip line because of corrosion.

**Neutralizing-amine** treatment was started in 1955. Shortly thereafter about 10% of the tubes in the low-pressure heater failed, in a small area where the first-pass tubes ran through a vent cooling section adjacent to the tube sheet. Inspection of the low-intermediate-pressure heater showed a hard blue-black scale on the tubes, and steel baffle plates were badly corroded. Neutralizing-amine treatment slowed down incidence of failure in the low-pressure part of the cycle, but didn't eliminate tube failure or baffle-plate corrosion entirely.



**MIXING TANK** and adjustable-capacity pump inject filming amine. Pump is controlled by makeup to evaporator and timer

# at Arkansas P&L

Late in 1955 the situation was reviewed. Since troubles were most severe in areas affected by evaporator vapor and were thought to be due to $CO_2$, there were two possible approaches: (1) pretreat evaporator feed and remove carbonates and bicarbonates or (2) protect the system from the effects of $CO_2$. Comparative costs indicated the latter approach and it was decided to feed a filming amine into the evaporator of one of the units. The filming amine would evaporate in the evaporator, condense in the low-intermediate-pressure heater and be carried into the cycle through the heater-drain system into the condenser.

To provide for continuous injection of a filming amine in the Unit-2 cycle, an adjustable-capacity pump was installed, discharging directly to the evaporator. A solution of 12% octadecylamine (diluted to 1%) was used; 22-Bwg-steel test strips mounted on fiber insulators were installed in drip lines from all low-pressure heaters. Strips served as a check on filming conditions as well as a means of obtaining corrosion rates. Film is difficult to identify; it gives the appearance of an unpolished waxed finish.

**Initial filming-amine feed** rate was 4.37 ppm, based on evaporator makeup flow. Neutralizing-amine feed was continued at reduced amounts, to keep condensate pH at 8.2. There was no evidence of filming for 18 days and then only in the low-pressure and low-intermediate-pressure heater drain lines. Filming-amine feed was then increased to 5.33 ppm and neutralizing amine stopped after 8½ weeks since test strips showed presence of film throughout the condensate system. At first, heater performance fell off, but after low-pressure heaters were physically cleaned with wire brushes performance improved and continued at a higher level than that experienced before filming-amine treatment was started.

While the unit was down for turbine-generator inspection, heaters were also checked. The hard blue-black scale on the steam side of the heater tubes had started to clean off, and baffle plates of the low-intermediate-pressure heater were much cleaner than before filming-amine treatment started. Film was detected on the diaphragms and low-pressure blades of the main turbine, but no adverse effect of the filming amine was noted on any equipment.

**Test strips** were then installed in Unit 1 as well. Here a neutralizing amine alone was used to produce a direct comparison. During a 61-day period, the corrosion rate on Unit-1 low-intermediate-pressure heater drip-line test sample averaged 32 mils per year, compared to 2.6 mils per year in Unit 2. Filming-amine feed was increased to 11 ppm and a 30-day test was run with these results:

| Location | Unit 1 | Unit 2 |
|---|---|---|
| L-p heater drain lines | 21.3 mils per yr | 2.2 mils per yr |
| L-i-p heater drain lines | 35.2 mils per yr | 0.65 mils per yr |

Since filming-amine treatment started, a marked decrease in boiler sludge has been noted. During the annual inspection just prior to the use of filming amine, 45 gal of sludge were removed. First year after the start of treatment this reduced to 20 gal; it is now down to about 11 gal of boiler sludge per year.

In the low-temperature portion of the cycle, film tends to bind corrosion products into a sticky substance. This is especially true during the early cleanup stages of treatment when corrosion products are migrating. Deposits build up in the tubes of the steam-jet vacuum pump, low-pressure heater and low-pressure-heater drip pumps.

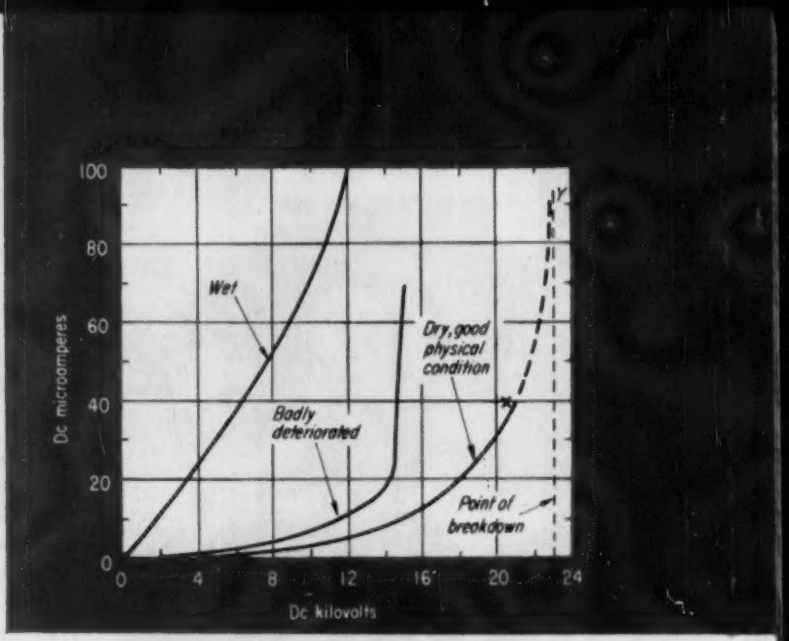
**As a result** of these tests, filming amine is now fed to both units at a continuous rate of eight lb per day of the 12½% solution. This gives concentration of 0.2 ppm in the condenser hotwell and is more than sufficient to protect the area directly exposed to evaporator vapors. Although filming-amine treatment costs about 3½ times as much as previous neutralizing-amine treatment, it compares favorably with cost of pretreating evaporator feedwater to eliminate carbonates and bicarbonates.

With filming-amine treatment well established, unit startup after a prolonged outage shows a more-rapid decrease in boiler-water turbidity. Residual film during the outage protects metal in the feedwater system from the corrosive effects of oxygen and other elements in the air. This has led to the use of a filming amine in another 30-mw unit in the Arkansas Power and Light system—unit operates seasonally with long periods of shutdown.

This article condenses and updates J P White's paper, *One utility's experience with filming amines*, presented at the 1958 Annual Meeting of the American Society of Mechanical Engineers in New York City.

By M E WILLIS, Supt, Electrical Maintenance
Station Operating Dept
Philadelphia Electric Co

**Knowing how to run a dc step-voltage test is only the beginning (January, p 182). Real usefulness comes when you know . . .**




**TYPICAL** leakage-current curves for different conditions of insulation follow patterns found by many tests on rotating machines

# What are safe values for insulation using low- and high-voltage dc test?

Dc testing is a valuable maintenance technique and can be effectively used in all productive plants regardless of size or scope of equipment involved. Extent and type of test for any individual application will depend on money available for test equipment; in some cases a complete range of test equipment may be desirable.

Low-voltage tests can be made on all sizes and types of apparatus, and have these factors in their favor: (1) relatively inexpensive equipment—a megohmmeter (2) semiskilled manpower required (3) simple and inexpensive records and (4) versatility—they may be used for periodic short-time tests or determination of insulation condition by dielectric absorption curves.

High-voltage tests are used to advantage to: (1) give more-accurate indications of insulation condition (2) test at voltages more realistic in reference to equipment rating (3) detect weak spots in insulation and allow preventive repairs before in-service failure (4) assure reliable operation until next scheduled maintenance period and (5) allow proof tests to be made easily and economically because small-sized portable equipment is used.

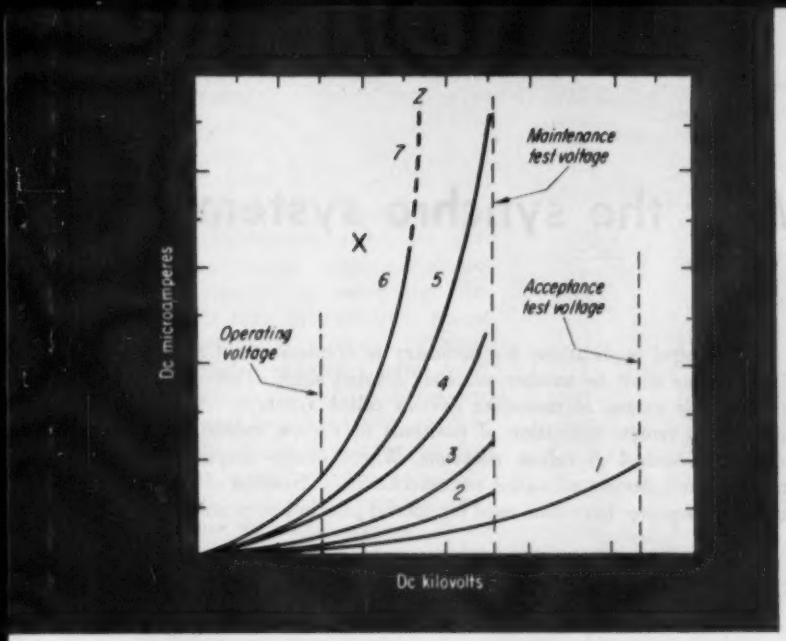
**Basic principles** of dc insulation testing were outlined in POWER, Jan 1960, pp 182-183, and capacitance, absorption and leakage currents were defined. It is the relative magnitudes of absorption and leakage currents that form the basis for the *absorption* or *time-resistance* test. Leakage (conduction) current is the important component when evaluating insulation by *step-voltage* test.

**L-v tests** are either *periodic* or *dielectric-absorption*. They are usually applied to installations of 440 v or less, at 500- or 1000-v dc. Periodic tests give you a continuous checkup, and only a small amount of time is needed to make them. They require a minimum of equipment; can be handled by semiskilled workmen. Tests can also be used during dry-out run on equipment that has become wet. Test values must be plotted on curve sheets along with information on temperature, atmospheric condition, etc. Program must include adequate followup and interpretation of tests as they are made.

Dielectric-absorption tests are made by one of two similar methods depending on instruments available: (1) 30-to-60-sec test with hand-operated equipment (2) 1-to-10-min test with power-operated equipment. Short-time test diagnoses insulation condition utilizing the *dielectric absorption ratio* of 60:30 sec, table.

The 10-minute test is made by holding voltage constant, usually at 500 or 1000 v, for 10 minutes. Readings are taken at definite time intervals and plotted. Shape of curve, and 10-min over 1-min reading (called *polarization index*), are used to judge condition of insulation. Insulation in good condition shows an appreciable increase in insulation resistance during time of continuous-voltage application. Wet, dirty or poor insulation shows little or no resistance increase. This test will not pick up cracks or voids unless they are full of dirt or other contaminants. Table is a rough guide for interpreting polarization-index (p-i) values.

Equipment with a large number of leakage paths may be affected greatly




**HYPOTHETICAL** leakage current curves for definite time intervals can be developed over long period by study of typical curves

## Dielectric-absorption test data

| Insulation condition | Dielectric-absorption ratio (short-time test) | Polarization index (long-time test) |
|---|---|---|
| Dangerous | — | Less than 1 |
| Poor | Less than 1.1 | Less than 1.5 |
| Questionable | 1.1 to 1.25 | 1.5 to 2 |
| Fair | 1.25 to 1.4 | 2 to 3 |
| Good | 1.4 to 1.6 | 3 to 4 |
| Excellent | Above 1.6 | Above 4 |

by vapor pressure or absolute humidity of surrounding air. Such equipment may have p-i values at least 25% below those in table regardless of actual insulation condition. If it's possible to test equipment at temperatures higher than ambient this effect should be minor.

**H-v dc tests** on rotating equipment give information on likelihood of failure, need for reconditioning to prolong service life and long-range progressive deterioration. A step-voltage test in which last step is high-potential will give reasonable assurance that insulation will be satisfactory until next test-inspection period. Voltage should be low enough, time of application short enough not to damage good insulation while still searching out incipient faults. Tests can, in many cases, be stopped before breakdown by interpreting leakage-current changes as test progresses. Need for reconditioning can be determined by observing changes that indicate moisture and dirt. Progressive deterioration is evaluated by comparing tests made at definite intervals.

Step-voltage tests may use fixed or varying time intervals — usually decreasing as voltage is raised. One of latter, for windings of suitable rating, is a 10-min 10-kv absorption test, plotting readings as test is made. Draw a smooth curve and use currents at 1, 3.16 and 10 min to calculate winding's polarization index. Calculation must be completed within 3 minutes of end of 10-min test. Set voltage to 12-kv immediately at end of 10-kv test. Using p-i calculated, enter time-leakage voltage-step curve and determine application time for each subsequent voltage step—test is continuous with no discharge or decrease in voltage between steps. Read leakage just before voltage increase.

Plot leakage current as test progresses. Curve will be straight line until internal-void ionization or corona activity appears as a slight break in curve. A very sharp break is often followed by insulation breakdown during subsequent steps.

Fixed-time step-voltage test must have a long enough time interval to reduce absorptive component to negligible value. Interval varies according to equipment size. Apply first voltage step; allow current to decay until nearly constant, noting time in minutes to this point. Increase voltage to next step and hold for same time interval. Repeat until final value is reached or test must be discontinued because of rapid rise in leakage current. Make next tests under same time and voltage conditions.

**Comparing** variable- vs fixed-time tests shows only one major advantage of variable-time: less total time needed to complete test. Disadvantage is difficulty of picking values for initial 10-min 10-kv absorption curve. A slight difference from curve in the 1-, 3.16- and 10-min values can change p-i over a wide range. Both tests give adequate results, but fixed-time test is much easier to administer with diverse equipment to be tested.

**Typical curves,** far left, show patterns found by many tests on rotating machines. Test voltage was removed at *X* and curve extrapolated. Tangent *Y* gives predicted dc puncture value, which should be considerably above test value based on operating voltage. Hypothetical curves, this page, were developed from typical curves. They cover readings taken at definite time intervals and show effect of aging. Curve *1* is initial acceptance test; *2* through *6* are maintenance tests showing gradual deterioration. Test *7* shows projected failure at *Z* if test was not discontinued at voltage *X*. Since *X* is close to ac operating voltage, schedule rewinding as soon as possible.

This article is based on a paper, *Dc testing as a maintenance tool*, originally presented at the Plant Maintenance & Engineering Conference in Philadelphia, Jan 27, 1960.

Plant

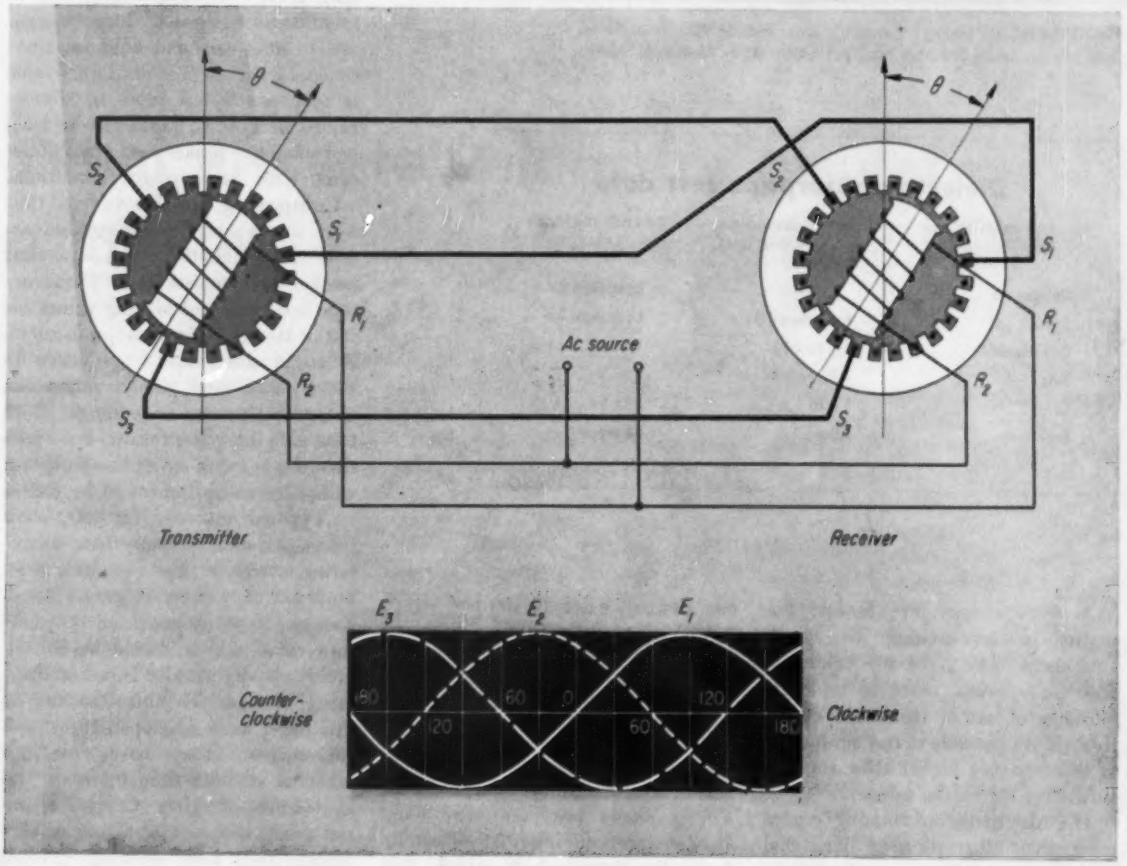
# Electrical Fact File

# Meet the synchro system

NO. 46: SYNCHROS

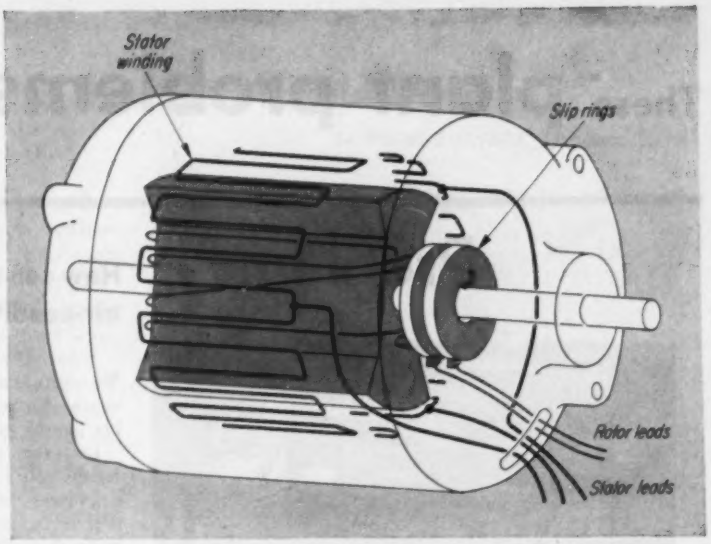
**In some control applications it's necessary to transmit exact angular motion of one shaft to another remotely located shaft. This is done electrically by means of motorlike devices called *synchros*. Applications include remote indication of positions of meters, valves, water-level gages; control of valves, rheostats. Where torque amplification is required such devices are called *servomechanisms*. Systems of several hundred horsepower have been used for special jobs in heavy industries.**

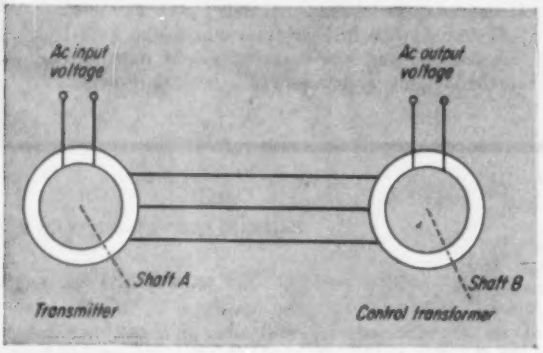
By NORMAN PEACH, Associate Editor



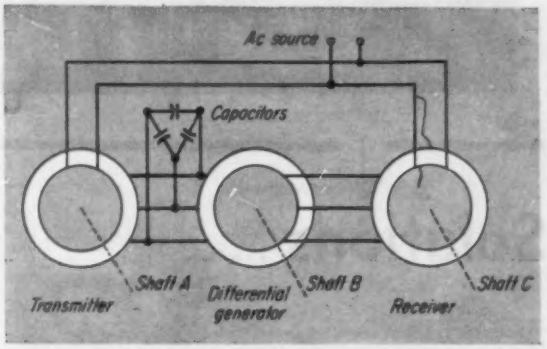

**SIMPLE SYNCHRO SYSTEM** consists of transmitter (generator) and receiver (motor). Synchros usually operate on single-phase ac with input supplied to the rotor. Distribution of transmitter-rotor flux is such that the voltage it induces in the stator depends on position of rotor. Stator has three interconnected windings (not three phases). Voltages for given transmitter-rotor angle $\theta$ are indicated by curves (note that these are *space* curves around stator, not time curves). Stator of receiver is connected so that voltages supplied by transmitter are across corresponding windings. When receiver rotor is at same angle as transmitter rotor, its flux cancels stator voltage and no current flows in secondary. When rotors are at different angles, current flows and torque is produced to bring rotors into correspondence. Mechanically moving transmitter rotor thus impels receiver rotor to follow. Several receivers can be driven by one transmitter of sufficient horsepower capacity

**CONSTRUCTION** of typical synchro has bobbin-wound rotor for primary and tapped, continuous single-phase winding for secondary. Receiver is same as transmitter except for mechanical damper (flywheel and clutch) and low-friction bearings. Some 3-phase synchros are built, and for large-power applications, conventional wound-rotor motors are sometimes used with interconnected rotors and suitable controls for particular service. If receiver motor has a different number of poles than transmitter, receiver and transmitter speeds can differ

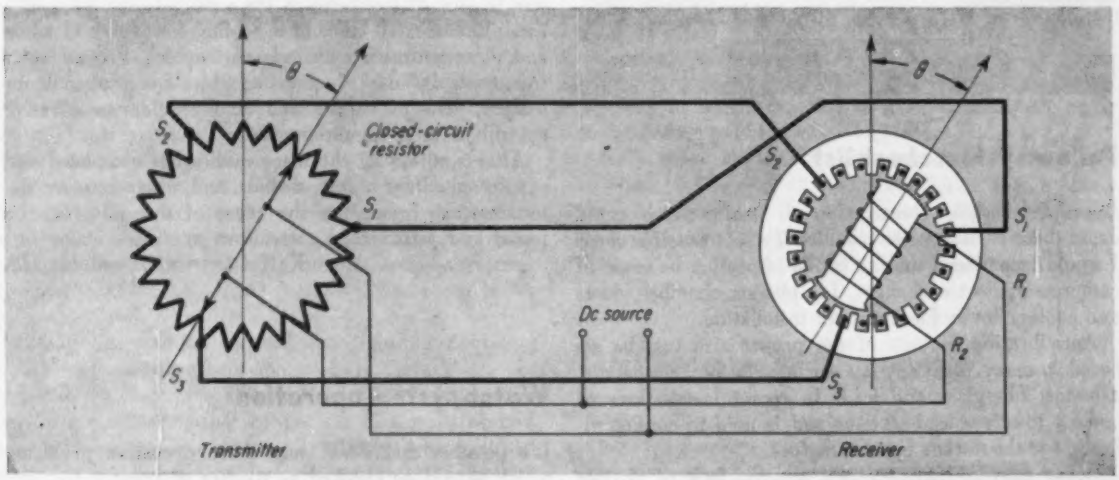



**CONTROL TRANSFORMER** is a synchro utilizing signal from transmitter for its primary or stator winding. If angle of control-transformer rotor is different from transmitter's, voltage is induced in secondary (rotor) proportional to displacement difference of shafts *A* and *B*. Output signal voltage may actuate instrument, relay, etc




**DIFFERENTIAL GENERATOR** has 3-part winding on both stator and rotor and is connected between secondaries of transmitter and receiver. If shafts *A* and *B* are moved, shaft *C* turns through angle equal to sum of difference of *A* and *B* displacements, depending on connection. Capacitors reduce the current drain on the transmitter.

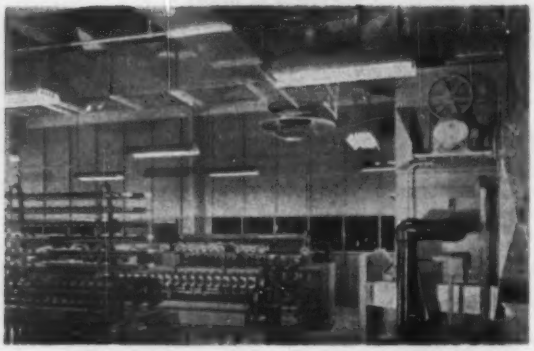



**DC SYNCHRO TRANSMITTER** consists of closed-circuit uniformly wound resistor tapped at three equally spaced points. Input is through two diametrical moving contacts. Output voltage varies with position of contacts

# These plant problems could well be yours...

## Problem . . .

### How can we quiet our air-conditioning system?

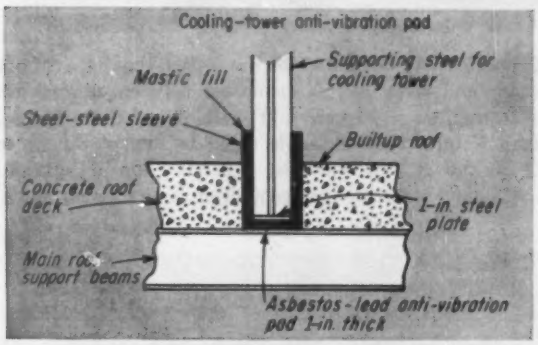


We operate a small manufacturing plant on the outskirts of a residential community. Our 1-story building houses product-assembly area and general offices.

Last year we installed centralized air conditioning for the entire plant, but something went wrong! Office employees complain about rumble coming through the ducts, manufacturing personnel complain about noise of compressor mounted in their area and even plant neighbors complain—about hissing noise of our outdoor evaporative-condenser unit.

We would like to hear from others who have had this problem and can suggest ways of quieting our air-conditioning system.—*BHW, January* POWER

## Solutions . . .




### Follow system check list

Improper design, construction or maintenance could cause these various noise troubles. To spot possible cause I would recommend that an initial inspection be made of compressor, heat exchanger, fan plenum chamber, ducts and cooling tower for improper installation.

Antivibration mounts of the proper size can be secured in many varieties: felt, springs, plastic, elastomers, asbestos, fiberglass and lead. In recent installations of cooling towers a lead-asbestos pad is used to confine vibration to the tower's upper structure.

Loose guards, improper belt tension, lack of flexible pipeline connections or malfunction of compressor controls can cause vibration and excessive noises. Erection of an acoustic-material wall or baffle confines noise.

If the fan is found mechanically correct, probably the ductwork or the flexible duct connector needs to be changed. Check ducts for loose supports.

Noise in the ducts may be just a loose damper. Possibly insufficient stiffeners were used in the duct construction, so vibration is being set up.

The cooling-tower trouble could be improper design of the fan and spray system or spray-system clogging due to lack of treatment in the cooling-tower water system. Biological fouling of a cooling tower due to slime and algae causes a multitude of troubles. Proper water treatments by use of chlorine, chlorinated phenols or metallic ions of copper and zinc provide an effective control of these conditions.

After a survey of the items outlined is completed and supplemented by a few air-flow and water-pressure determinations I am sure the cause of the noise can be found and satisfactory corrections applied.

K N BANTHIN, *Broadview, Ill.*

### Watch system operation

It's possible that *BHW* may have operation problems which should be checked as sources of noise.

Mechanical noises in air-distribution system may be caused by fans operating in imbalance due to dirt ac-

# ...Here's how Power readers would tackle them

LAWSON STEWART, Associate Editor

cumulations, dirt or mold collecting on evaporator fins, poorly installed canvas silencer belts between machine and ductwork, loose or worn fan belts, vibrating parts of cabinet-frame jacketing (if used), improperly supported lines that throb and vibrate under load, poorly placed or no flexible joints in the machine assembly. It's just barely possible that pulleys were swapped.

Compressor noises may be confused with those mentioned above, and if unit went into a wooden-shed annex, light construction may resonate or serve as an amplifier for thumps and throbs that would go unnoticed in masonry building. *BHW* fails to state if the equipment is mounted on a concrete slab of sufficient bulk to withstand machine stress and strain, including expansion and contraction factors.

Hissing noise heard at evaporative-condenser unit may be due to "cracked" valve on makeup water line emitting under high pressure and low volume.

P L Ziemke, *Clinton, Tenn.*

## Check sound transmission

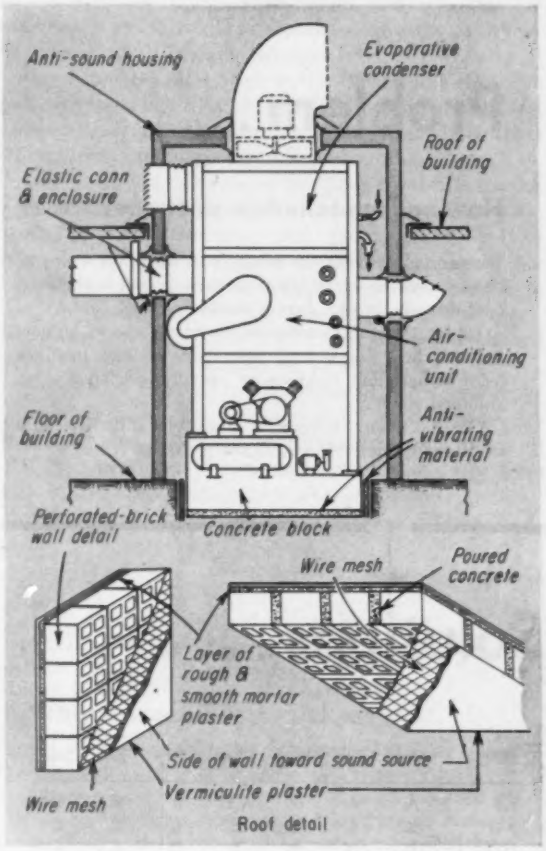
Taking the problems as *BHW* presents them . . .

Rumbling in ductwork suggests several causes. Blower may be operating on unstable part of its performance curve, causing surging and rumbling. This could be aggravated by ductwork so thin that it undulates with each air pulsation. Try speeding up blower if the motor will take it. Add rigid sound-absorbent material inside ductwork if necessary. Dampers, improperly designed elbows at blower's inlet and discharge and lack of turning vanes in elbows can all contribute to noise of an air-distribution system. Check these points and solution may be obvious.

Compression noise can be minimized by isolating machine from its surroundings. Compressor should be mounted on vibration-absorbent pads or springs, making sure that frequency of these vibration absorbers is not the same as that of compressor so a resonant condition will not exist between the two, amplifying noise or creating annoying beat frequencies. All piping should be isolated from hangers by wrapping pipe or hangers with sound-absorbent material. Walls of compressor room should be covered with enough sound-absorbent material to reduce noise on outside of the room to an acceptable level.

Piping hiss can be reduced by enclosing discharge piping in sound-absorbent material. If there is an objectionable hiss coming from evaporative condenser this can be quieted somewhat by putting thin walls around the condenser, making sure that it still gets plenty of air. Wall can be attractively designed and add to the appearance of the building.

J Belunas, *Brooklyn, N. Y.*




## Build anti-sound wall

I suggest that *BHW* make separate foundations and supports for all equipment subjected to alternating or rotating movements. Only elastic sleeves should connect equipment to building piping or duct systems. An anti-sound housing might also be helpful.

Sketch above shows a typical installation with usual auxiliaries for air-conditioning unit. The sketch also shows enlarged details for anti-sound wall which I have found to be effective, practical and inexpensive.

J Boresta, *West Englewood, N. J.*

## Watch for more on this problem

Power readers responded to *BHW*'s request for information by flooding our desk with detailed solutions. Some were so meaty and extensive they could not be summarized in available space. Therefore, coming issues of Power will carry these answers as full articles.

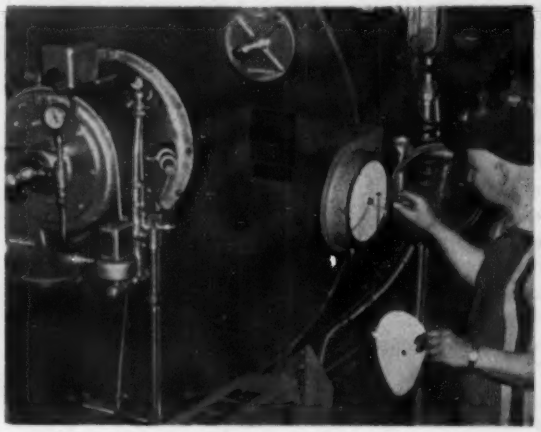
# Problem . . .

## How can we schedule shift operation?

We man a small 600-hp 100-psig steam plant with one chief and three operating engineers. Steam is required continuously except during annual outage.

Under these circumstances manning charts become a headache. For normal operation we can just get by, but handling sickness or vacation period has us stumped.

Could readers suggest a workable shift schedule to fit our needs?—*WAG, January* POWER



# Solutions . . .

| Shift | Mon | Tue | Wed | Thurs | Fri | Sat | Sun |
|---|---|---|---|---|---|---|---|
| 7-3 | A | A | A | A(E) | B | B | B |
| 3-11 | B | B | C | C | C | C | C |
| 11-7 | D | D | D | D | D | A | A |
| 7-3 | B | B | B | B(E) | C | C | C |
| 3-11 | C | C | D | D | D | D | D |
| 11-7 | A | A | A | A | A | B | B |
| 7-3 | C | C | C | C(E) | D | D | D |
| 3-11 | D | D | A | A | A | A | A |
| 11-7 | B | B | B | B | B | C | C |
| 7-3 | D | D | D | D(E) | A | A | A |
| 3-11 | A | A | B | B | B | B | B |
| 11-7 | C | C | C | C | C | D | D |

## Hire extra shift operator

With one chief and three operating engineers to cover 3-shift 7-day-a-week operation of a 600-hp boiler plant someone must work over 40 hr a week. If the crew is limited to a 4-man group, overtime must be worked to cover one shift each week and any absences due to sickness or vacation. It is unlikely that any vacation time can be scheduled during annual shutdown period as the entire crew would then be needed for maintenance and inspection. A shift schedule for this type of operation is shown at left, covering a 4-week cycle.

In this schedule four men designated as *A-B-C-D* rotate around a 4-week cycle. At every third "on-off" period each man has four consecutive days off. This long period is a very attractive part of schedule. But vacations and sickness are still a problem because others must work 12-hr shifts to take up any absences.

Does the owner or supervisor of this plant drive his car around without a spare tire? I'll bet he doesn't. Then—why is he attempting to operate this steam plant without proper personnel? Also, unless someone else is doing the routine maintenance, engineers are working extensive overtime just to keep the plant operating.

Assuming this plant is paying its engineers prevailing wages and no serious labor problem would result from reduction of excessive overtime, I believe the supervisor should add a fifth man to his crew. This man would free the chief for normal day work plus the rotating shift each Thursday (denoted by *E* on chart) and eliminate regular weekly overtime. Also, the chief would be available to fill in for vacations and sickness.

In that case over one-half the chief's time would be used for relief of other engineers—formerly done at overtime rates. Also, as some maintenance he would handle was formerly done on overtime, the net saving would probably exceed cost of the addition of a fifth man.

An experienced chief engineer on day shift, except for relief of vacation and sickness, should also improve plant's operating efficiency and permit a system of preventive maintenance.

K N BANTHIN, *Broadview, Ill.*

| Watch | Sun | Mon | Tues | Wed | Thur | Fri | Sat |
|---|---|---|---|---|---|---|---|
| 12-8 | A | A | A | A | A | D | D |
| 8-4 | D | D | B | B | B | B | B |
| 4-12 | C | C | D | D | C | C | C |
| 12-8 | D | D | A | A | A | A | A |
| 8-4 | B | B | D | B | B | B | B |
| 4-12 | C | C | C | C | C | D | D |
| 12-8 | A | A | A | D | A | A | A |
| 8-4 | B | B | B | B | D | D | B |
| 4-12 | D | D | C | C | C | C | C |
| 12-8 | A | D | D | A | A | A | A |
| 8-4 | B | B | B | B | B | D | D |
| 4-12 | C | C | C | D | C | C | C |

## Work 42-hr week

*WAG* should try the above schedule for normal steaming watch. One cycle is completed every four weeks. Chief engineer takes the day watch and newest man takes rotating shift watch—but doesn't have a "long shift" where he has to report back eight hr after knocking off work. My schedule has these advantages: each cycle dovetails with the next cycle. All watches have an equal number of weekends off and extra shifts. All watches average 42 hr per week.

During temporary sicknesses (less than a week) the sick man's watch should be split, with adjacent watches each taking four hours. This evens out in the long run.

During vacation periods or long illness of one watchstander, investigate the possibility of hiring a competent vacation relief, or schedule vacation to begin on Sunday. Break normal steaming watch at 12:01 am Sunday and put remaining three men on standard 8-hour day, 56-hr-per-week. When resuming normal steaming watch, always maintain continuity by starting watches at same position of the watch cycle they were broken at.

C A SHUTTLEWORTH, *Woodbury, Conn.*

## Hire part-time help

Problem of shift coverage is common in small plants where manpower covers just normal operations and the budget doesn't permit hiring additional full-time help. Shift schedule would depend on many factors: How high is the overtime rate?—some union contracts call for overtime after 35 hr. Will morale or efficient operation be affected by too much overtime?

One solution I have seen work is to employ part-time help, putting them in a regular shift schedule or calling them in only when needed, as in the case of sickness or vacations. This cuts continuing overhead.

In selection of this type of help, don't waive license or experience requirements. Civil-service employees generally have more vacation time and holidays off than others in industry and are a source of manpower. Another source of part-time help is men who have long years of experience and are now on semiretired status. They are interested in a few hours' work a week and very often will be available on short notice.

Solutions I have given above should not, however, be substituted where the real need is for an additional operator. A clear survey should be made of operation, including percentage of sickness and vacation, and from this a manpower requirement can be reached.

F J DUFFY, *Valley Stream, N. Y.*

## Your April problems

### What causes burner pulsation?

We operate seven small refractory kilns for firing small batch orders or test runs. All kilns are equipped with air-aspirating gas burners, with air supplied by one fan through a header duct. There are no dampers in air system; air to each burner is controlled by a valve in each burner assembly.

Our problem occurs when lighting off one kiln with the remaining six out of service. Gas flame pulsates and sometimes goes out. We would like to know how to prevent pulsations. Can POWER readers help us?

*—EFL*

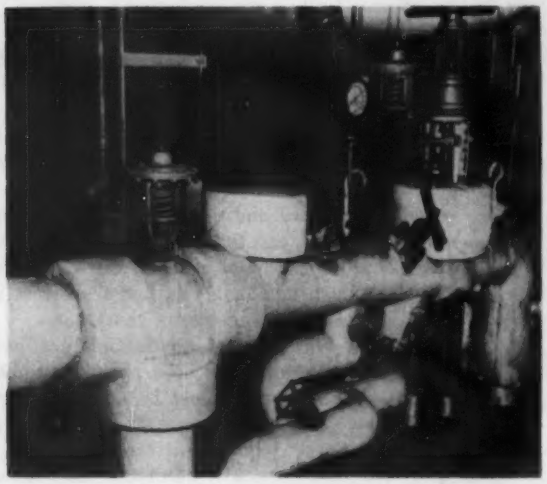
### Can we use steam to fight bunker fires?

We have a 700-ton coal bunker at the top of our boiler house. Periodically we get a batch of poor coal and have a bunker fire. It has been suggested that we fit the bunker with perforated pipe and use steam to extinguish these bunker fires or use a steam hose with a pipe extension to lance into the coal fire and extinguish it by local steam blanketing.

Have readers any knowledge of this method of extinguishing bunker fires? I would appreciate any information that they can furnish on the use of steam in bunker-fire fighting.—*MGK*

**Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches**

# Timely **practical ideas** to help solve



## This pressure reducer supplies plenty of l-p steam

Cooling high-pressure high-temperature steam with water in this pressure-reducing-desuperheater unit provides the Long Island Lighting Company with low-pressure steam for plant auxiliaries. Plant is the Edward F Barrett Station.

Supplied with steam from the main boilers at 1800 psig and 1005 F, the carburetor type desuperheater handles station's l-p steam needs, which vary from 500 to 17,000 lb per hour.

Unit was designed to reduce pressure from 1800 to 165 psig, temperatures from 1005 F to 385 to 400 F, each in one step. It holds these final conditions under rapid load changes. Maximum design flow is 25,000 lb per hour through the system.

Steam supplied by the installation heats the station and feeds combustion-air-preheater coils when station generating-unit load falls below a predetermined minimum. When this occurs, the desuperheater load may change from 3000 to 17,000 lb per hour within 30 seconds.—*Courtesy, Blaw-Knox Co, Copes-Vulcan Div*

## Ever pull a boner?

Why not send it in? If we accept, you'll get $15. And how about a *What would you have done?* or a *Practical idea* or even an incident that might get our mutual friend Marmaduke to sound off.—STEVE ELONKA

## Flush valve does it

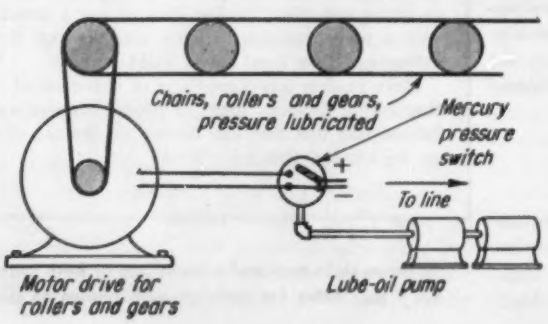
We have several processing machines in our plant requiring a measured quantity of water periodically, which an operator adds. Water feeds out on the work as operator adjusts the flow while watching a clock. This tells him how long it takes to use up the measured quantity of water.

We used to measure the two gal of water by filling a container up to a line. To speed up this measuring operation we installed a flush valve, the type used on urinals. We adjusted the valve so it delivers the desired two gal. Valve delivers an accurately measured quantity in a short time, in spite of line-pressure variations.

If other plants must add measured quantities of liquid to tanks or mixtures as part of their regular operation, they'll find this method quick and easy. Valve should be one with "no-hold" feature, delivering same quantity whether handle is held down for a long or short period of time.

H KOSLOW, *Bronx, N. Y.*

## Now, lube failure can't tie up our plant's production line




Our plant uses a very expensive kiln-drive arrangement. If lubrication should fail, the heat from our kiln coupled with high friction at bearings would tie up plant production. We hooked a mercury pressure switch in our line to the gear motor, sketch, to prevent this. Now, if pressure fails, motor driving the gear train stops immediately and no damage is done.

T MULLIN, *Seattle, Wash.*

# your tricky design and maintenance problems

STEVE ELONKA, Associate Editor

## Step up performance of your differential chain hoist

Differential chain hoist is inefficient, but it provides an economical lifting device for infrequent use. We have several in our plant and have discovered a technique to use them better.

Hoist consists of a continuous double loop of chain with a double sheave block at the top and a simple sheave block at the bottom of one of these loops of chain, sketch. At times we wish to lift a load only to find the load hook is up near the top of its travel. This hoist (1-ton size) requires 30 ft of chain to be overhauled to lower the hook one ft. This means we would have to pull 180 ft of chain through the sheaves to lower the hook 6 ft. There *is* an easier way!

We pull the pin from the lower sheave and remove sheave and yoke. We then place them on the other loop of chain where they are down, ready to lift the load. At one time we had six heavy dies to lift up to a truck. We shifted the sheave after each lift and saved ourselves some manhours.

H KOSLOW, *Bronx, N. Y.*

## What would you have done?

I service refrigerating equipment as a side line. A customer of mine installed a new 3-ton walk-in refrigerator of 220-volt load, single phase. Job was tested and accepted. But when my customer got his first power bill it was five times greater than he had ever paid before. He naturally hit the overhead after popping his safety valve.

First he jumped all over the contractor who installed the box. That gent brought in his best men, who checked the electrical system but found nothing. Then it was my turn to look the job over.

I had no reason to doubt the new equipment. It had been working beautifully for two months. Besides, some good men had checked and rechecked it. But I figured I might as well start from scratch.

First I went over the amp load from the main switch to every sub breaker on the panel. My total was 25 amp less than the power going into the watthour 15-amp 230-v 3-wire single-phase meter. This gave me a lead. I called the power company, but got no sympathy. They said if the meter was showing 40 amp, 40 amp was what we were getting. They threatened to put in a larger meter, which would run up our cost per watthour. So no luck in that department.

A few weeks later the poor little meter couldn't take it any longer. She burned up her terminal block, and the power company had to replace her. I was there when their meter lab man showed up. He disconnected all the lead and mounting screws, but the meter wouldn't budge. He finally pried it off the panel with a long iron bar. Then he found the trouble—but was he surprised.

Evidently when the refrigerator was built, a carpenter had driven a nail through the back of the wooden power panel. Nail went through the motor case and into one of the two current coils in the meter. That broke a circuit through the coil to ground, grounding the meter case. After new meter was installed, current load settled at 12 amp in place of 40. What would *you* have done?

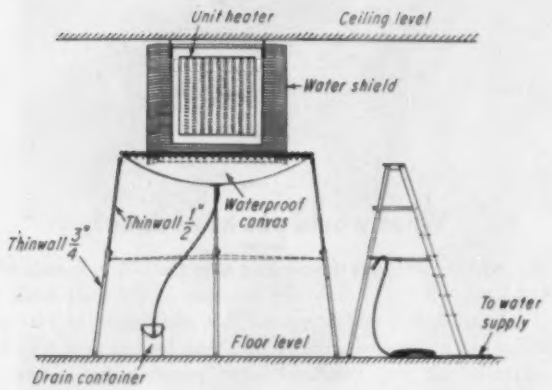
J WHYTE, *Lynwood, Calif.*

## Can you . . .

draw a sketch showing how a diode works? Page 227, Vol 1 of *Standard Plant Operators' Questions and Answers* shows you, complete with an easy-to-understand explanation.

## Do you know . . .

that gas-lubricated bearings have been successfully tested up to 500,000 rpm, compared with oil-lubricated bearings' top of 100,000 rpm? Oil-lubricated bearings are usually limited to temperatures from –60 to +800 F. Gas-lubricated bearings operate from –450 to +3000 F. While bearing loads are lower for gas lubrication, there's no leakage—a vital point in process work.




## Here's a way to clean unit heaters at minimum cost

We use a cleaner and degreaser in 16-oz spray cans. It's an excellent remover of dirt and grease in hard-to-reach places. The manufacturer recommends spraying the unit to be cleaned liberally, letting it stand for 15 to 20 minutes, then spraying with a water nozzle.

We made a water retainer at little cost that does a good job. First locate a beach or tractor umbrella of about 6-ft dia, depending on size of largest unit heater. Bend a circle out of ½-in. thinwall conduit. If two or more lengths are needed, use a short metal insert and weld ends together. Bend conduit slightly larger than diameter of umbrella covering. Punch and fasten eyelets around outer edge of covering; space about 8-in. apart.

To control drainage water, make hole in center of covering. Use a ¾-in. pipe coupling with two pieces of 20-ga metal about 6 in. in diameter. Drill hole in center of one piece to correspond with inside diameter of pipe coupling and weld in place on end of coupling. Drill a hole in remaining piece large enough to slip over coupling. Use asphalt sealer between sheet-metal flanges and covering. After sealer is applied freely and flanges are in place, rivet units together to form a watertight seal. Use ¾-in. hose adapter screwed into coupling and connect drain hose. Lash the covering to conduit ring with a sash cord.

Ceiling height isn't critical if you provide sliding adjustment for legs. Make up three leg straps of ⅛-in. flat bar, ½-in. wide, 6-in. long. Bend one end of each around conduit; space them 120-deg apart to form a tripod. Make up three legs—½-in. thinwall slides freely inside ¾-in. thinwall. Cut legs long enough to reach highest unit when adjusted and weld ¼-in. nut in place over hole.

Use ¼- by 1-in. wing bolts—if they're not available you can easily make them. Bolt or weld ½-in. conduit legs to metal straps. To keep tripod legs from spreading, weld a small chain link a few in. below wing bolt. Light chain or sash cord works fine as a tie between legs.

Before spraying, check motor and cover or seal all openings to prevent moisture damage. A water shield may be very useful in back and along sides of unit heater to prevent overspray. You can use a light-gage sheet metal or waterproof covering.

With tripod and water shield in place water spraying shouldn't be too tough. I'll admit that water isn't always accessible, but usually there's a janitor's sink or rest room handy.

W R Worthington, *Boise, Idaho*

## My biggest boner

It turned out to be what plant engineers call 'headache week.' Some goofup happened every day. So when the utility man dropped a bottle of oxygen from the catwalk, busting the electric-driven feed pump, we were warned the next boner would mean the jolly heave-ho.

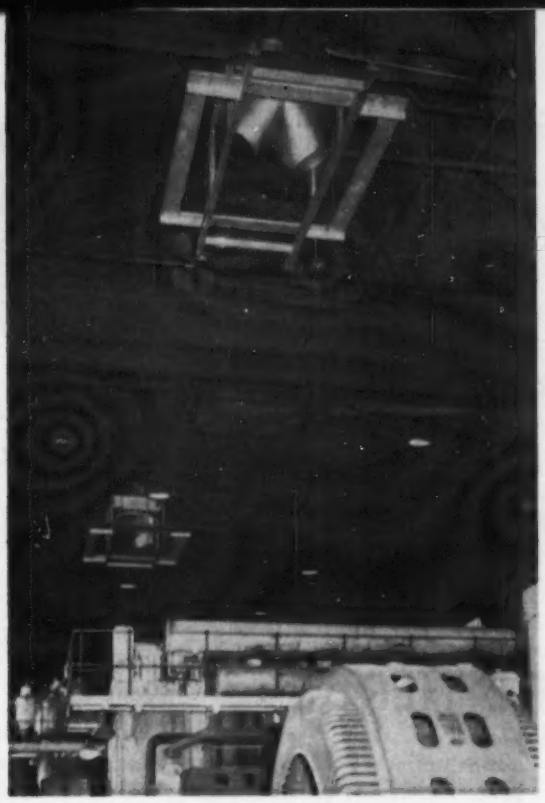
I picked up the pump parts for making repairs. Then I started up our standby steam duplex pump and put it on the line. A new electric pump was promised in three weeks.

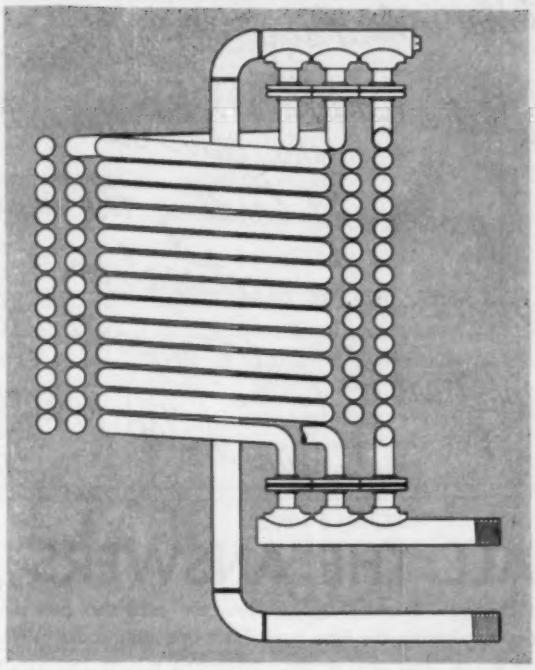
Friday night after securing the plant I felt relieved—two days of relaxation. Man, I needed it! But the super stopped me as I was getting into my car. "It's gonna get cold, Moon. You'll have to come in about midnight Saturday to warm up." Then he added, "You better pack that duplex while you're in because we'll depend on it for weeks."

Saturday I packed the pump, warmed things up and got ready to shove off. Then I noticed the valve glands were leaking. I grabbed a socket wrench and started to take up on a nut. Just then the pump made a stroke, jammed the wrench against the stud and busted the valve lever.

We had no welding equipment. It was Sunday and all the shops were closed. What to do? I grabbed the phone book, looked for the pump-manufacturer's rep. Reached him, finally—at his home. But I got some education the hard way about manufacturers' reps. He didn't even stock a cotter pin—only took orders. He'd need 30 days to get me parts. And, he pointed out, there was no other pump of that type in nearby plants. Then I started calling weldors and finally got an auto-repair-shop guy to come out. He did the welding and I completed the repair. Since then, I only use an open-end wrench on pump-packing glands.

Tom Mullin, *Seattle, Wash.*





**Unit heaters spotted overhead plus home-grown coils in diesel exhaust trunks saved $12,000 in this . . .**

# Do-it-yourself space-heating system

By FRANK E NAVIN*

For 46 years the town of South River, N. J. (pop. 15,000) has operated its own water and light plant. And for 40 of these years this plant had no heating system. Power was generated exclusively by three 1500-hp diesels which released some heat into the barn-like plant, but the amount meant nothing from a comfort standpoint. Temperatures in winter got as low as 20 F and plant operating personnel had to dress like Arctic explorers. Makeshift electric strip heaters were set up in critical areas such as washroom and locker room but were far from satisfactory.

In 1954 we installed two new, bigger engines and retired the three old units to standby service. This seemed an excellent opportunity to do something about the winter discomfort situation and we asked for bids on a heating-system installation. We received three proposals, one for a waste-heat boiler utilizing engine exhaust and costing about $20,000, two offering oil-fired boiler systems, each costing some $29,000. Estimated daily operating cost of latter would be about $20 maximum.

**This was much too rich** for our budget, so we tackled our own system design. Cutting into the muffler section of the exhaust trunk from each of the two engines, we removed the baffles and inserted nested spiral coils of our own design, drawing above (coils later proved to quiet the exhaust more than the baffles had). Coils are connected to a water intake header at the bottom and discharge header at the top, giving parallel flow with exhaust gases. Open system's expansion tank, located high in building trusses, has illuminated gage glass visible to operator on floor. Coil outlet leads down to circulating pump which sends heated water to revolving-discharge unit heaters, photo, spotted in main generator room, machine shop, oil-storage room and locker room. From heaters, water returns to expansion tank. Makeup can be added by operator as needed.

**Diesel-exhaust** temperature varies between 600 and 750 F. Heating system's water temperature runs between 180 and 220 F and supplies heat for fuel oil as well as the building. Total system cost was about $7500; daily cost for pump power is about 70c. One diesel supplies all needed heat. Our system saved at least $12,000 initially, costs little to use and keeps the place warm as toast.

*F E Navin formerly was Superintendent, Board of Public Works, Municipality of South River, N. J.

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*(Continued on opposite page)*

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| 250 | G.E. S.B. Open | KT | 1800 |
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| 100 | West. TEFCBB | CS-770 | 1200 |
| 100 | G.E. S.B. Open | KT-347 | 1200 |
| 100 | West. SSB Open | CS-867 | 1200 |
| 100 | F.M. B.B. Open | H200 | 900 |
| 100 | F.M. B.B. Open | H | 720 |
| 100 | F.M. B.B. Open | H | 600 |
| 75 | West. B.B. Open New | CS-444 | 3600 |
| 75 | Reliance B.B. Splash | 505 | 1200 |
| 75 | F.M. B.B. Open | H | 900 |
| 75 | F.M. B.B. Open | H | 600 |
| 60 | West. TEFCBB | CS-443 | 3600 |
| 60 | G.E. TEFCBB | KF-445 | 3600 |
| 60 | L.A. TEFCBB-XP | EX-445 | 3600 |
| 60 | L.A. TEFCBB | JX-445 | 3600 |
| 60 | West. TEFCBB | CS-445 | 1800 |
| 60 | Cont. TEFCBB | NP-504 | 1800 |
| 60 | G.E. TEFCBB | K-564 | 1800 |
| 60 | West. TEFCBB | CS-505 | 1800 |
| 60 | G.E. S.B. Open | K-444 | 1800 |

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FREE CATALOG. This is a partial listing. We are continually changing our stock, and can fill your requirements at any time. Send for our free catalog. In Stock, fractional horsepower up to 500.

Motors, Control Equipment, AC and DC Generators, MG sets and transformers.
PHONE or WIRE us COLLECT
LARGE LINE OF SLIP RING MOTORS & CONTROLS.

## POWER EQUIPMENT CO.

8 CAIRN STREET • PHONE BEverly 5-1662 • P O BOX 534 • ROCHESTER 2 N.Y.

Circle 506 on Reader Service Card

## POWER EQUIPMENT DIVISION

**BOILERS**

3—1296 HP B&W Sect. Steel Header 275 PSI Gas/Oil Fired
2—200 HP 160 PSI Keeler, Stoker Fired
12—NEW UNASSEMBLED B&W, F.W. C.E. with Superheater, Economizer, Soot Blowers, Oil Burners, Steel Encased—Rated:
122,500#/hr, 565 PSI, 850°F
44,500#/hr, 450 PSI, 735°F
35,000#/hr, 285 PSI, 577°F

**A. C. MOTORS — 3 ph. 60 Cy.**

| Qu. | HP | Make | Type | Speed | Volt |
|---|---|---|---|---|---|
| 1 | 350 | A.C. | AZZ TEFC X.P. | 3600 | 2300 |
| 1 | 250 | Cont. | NP TEFC X.P. | 720 | 2300 |
| 1 | 200 | G.E. | KF TEFC X.P. | 3600 | 2300 |
| 1 | 125 | G.E. | KF TEFC X.P. | 1800 | 2300 |
| 3 | 100 | G.E. | K TEFC X.P. | 1800 | 440 |
| 1 | 150 | West. | CW Slip Ring | 1800 | 440 |
| 3 | 75 | West. | CW Slip Ring | 1800 | 440 |
| 3 | 30 | West. | CW Slip Ring | 1200 | 440 |

**GENERATOR SETS**

11—1250 KVA Natural Gas Engine Sets 3/60/2400/4160 with switch gear *(can be seen running)*
1—500 KW Condensing 200 PSI Turbine
1—500 KW G.E. Non Cond. 265 PSI, 0-10# BP Turbo Generator

**TRANSFORMERS**

1—6000 KVA 3/60/44,000—4160 Substa.
3— 333 KVA 1/60/2400/4160 Y—480

**CRANES**

4/10 ton OET 47'3" Span 75' Lift AC
25 ton Powerhouse 36'6' Span AC

## HEAT & POWER CO. INC.

60 East 42nd St., New York 17, N.Y.
310 Thompson Bldg., Tulsa 3, Okla.

Circle 511 on Reader Service Card

## DUAL FUEL DIESEL ENGINE GENERATOR UNITS

1050 KVA Nordberg supercharged dual fuel diesel engine generator unit 3 phase 60 cycle 2400 volts 327 RPM. New 1947—Excellent condition.

1250 KVA Worthington supercharged dual fuel diesel engine generator unit 3 phase 60 cycle 2400/600/480 volts 360 RPM. New 1949—Excellent condition.

1420 KVA Fairbanks Morse opposed piston diesel engine generator unit 3 phase 60 cycle 2400/4160/480 volts 720 RPM. New 1950—Excellent condition.

The above units are still installed and complete with all auxiliaries as in operation.

**INTERNATIONAL POWER MACHINERY CO.**

1612 Union Commerce Bldg. — MAin 1-9514
Cleveland 14, Ohio

Circle 507 on Reader Service Card

## *EXCELLENT TRANSFORMERS*

3—833 KVA WESTINGHOUSE

3—833 KVA Westinghouse transformers Type SL, Class OA Voltage rating 55,000 to 2400 Volts, with taps below. Impedance 7.1%. Exc. Condition.

3—250 KVA General Electric Pyranol Transformers. Type H. Form RA. 2400/4160Y to 240/480 V., w/Taps. Excellent Condition.

*Write For Complete Listing*

**MACHINERY CENTER INC.**

PO Box 964 HU 4-7001 Salt Lake City 10, Utah

Circle 509 on Reader Service Card

## MODERN GE RECTIFIERS

3/60/13,200 AC to 600V. DC

4—1000KW Mod. 6RC-45-CD6
2— 500KW Mod. 6RG-45-CH2

Six Tube Ignitron Pump Type
Full Automatic AC & DC Controls

Can be inspected on original locations now in 1948, still like new, actual photos are available, very low price for lot.

**S. M. DAVIS**

525 N. 20th, E. St. Louis, Ill.

Circle 512 on Reader Service Card

## FOR SALE 14 NEW TURBINES

4 horizontal, 10 vertical, Westinghouse
Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.
Will sell turbines separately if desired.

*Price reasonable.*

Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volts. Used one year.

**G. M. De ROSE**

2457 WOODWARD AVE.
706 DONOVAN BLDG.
DETROIT 1, MICH.

Circle 508 on Reader Service Card

## MODERN POWER BOILERS

| | | |
|---|---|---|
| 1—Babcock & Wilcox | —200,000#s— | 625 psi |
| 1—Combustion-Engineering | —110,000#s— | 625 psi |
| 1—Babcock & Wilcox | — 90,000#s— | 288 psi |
| 2—Babcock & Wilcox | — 85,000#s— | 250 psi |
| 1—Combustion-Engineering | — 75,000#s— | 725 psi |
| 1—Combustion-Engineering | — 60,000#s— | 250 psi |
| 1—Riley | — 60,000#s— | 290 psi |
| 2—Combustion-Engineering | — 50,000#s— | 250 psi |
| 3—Combustion-Engineering | — 50,000#s— | 291 psi |
| 1—Babcock & Wilcox | — 45,000#s— | 450 psi |
| 2—Union Iron Works | — 40,000#s— | 250 psi |
| 2—Babcock & Wilcox | — 30,000#s— | 250 psi |
| 1—Babcock & Wilcox | — 27,500#s— | 450 psi |
| 2—Babcock & Wilcox | — 18,000#s— | 250 psi |

*Dismantling and re-erection under one responsibility*

**MIDWEST BOILER & TURBINE CO.**

Warner, New Hampshire

Circle 510 on Reader Service Card

## FOR SALE

1500 KW, 80% Power Factor, 3 phase, 60 cycle, 2300 volts, 3600 RPM, General Electric 5-stage noncondensing steam turbine generator unit, 375 PSIG, 700° FTT, 125# exhaust back pressure, complete with direct connected shaft exciter and switchgear. Excellent condition—available immediate delivery.

**EUCLID ENGINEERING CORPORATION**

909 National City East Sixth Building
Cleveland 14, Ohio

Circle 513 on Reader Service Card

FROM AIRCRAFT CARRIER
"ENTERPRISE"

# [4] 1000 KW
# GEARED
# TURBO-GENERATORS

*For Condensing*
*or Non-Condensing*

**1000 KW TURBO-GENERATOR COMPLETE WITH CONDENSERS CIRCULATING PUMPS CONDENSATE PUMPS AND SWITCH GEAR**

GENERATOR: 1000 KW — type ATB-2 — G.E. — form H.L.—1250 KVA—8/60/450—1805 amps—3600 RPM—0.8 P.F.—field amps 67—typical serial No. 5358205—with 120 volt 11KW DC exciter—compound wound.

STEAM TURBINE: 1000 KW G.E.—type FSN-4R-FN30-85TG—rated 7964 RPM—exhaust 1 lb. absolute when condensing.

REDUCTION GEAR: S-119—form A—RPM 7964/3000.

TURBINE STEAM PRESSURE: 375 lbs—175°F superheat-exhaust pressure 1 lb. absolute when condensing. Can be used condensing or non-condensing.

*BUILT AS MARINE UNITS USING FINEST MATERIALS. DRIP - PROOF CONSTRUCTION. UNITS ARE 14' LONG — 7'8½" WIDE. MOUNTED ON PRE-FAB SUB-BASE.*

## OPERATING CONDITIONS

1. The turbines are designed for normal operation condensing at 375 lb per sq in gauge, 175°F superheat steam at throttle, and 1 lb. per sq. in. absolute at the turbine exhaust flange
2. The turbines will operate successfully condensing at 375 lb. per sq. in gauge, 0°F superheat at throttle, and 1 lb. per sq. in. absolute back pressure at the turbine exhaust flange.
3. The units have an overload capacity of 25% (1250 KW, 0.80 p-f) for two hours with normal main and exhaust pressures.
4. The units have an overload capacity of 50% ((1500 KW, 0.80 p-f) for five minutes with normal main and exhaust pressures.
5. The units will deliver normal output (1000 KW, 0.80 p-f) with main pressure 20% below normal and with a back pressure of 2 lb. per sq. in. absolute at the turbine exhaust flange.
6. The turbines will operate successfully with a maximum main pressure at 450 lb. per sq. in. gauge and with a maximum superheat of 200°F at the throttle.
7. The turbines will develop 300 KW with 375 lb. per sq. in. gauge, 175°F superheat steam at throttle, and 20 lb. per sq. in. gauge back pressure at the turbine exhaust gauge.
8. The turbines will operate successfully when extracting steam from the second-stage shell of the turbine. An automatic pressure regulating valve and a non-return valve should be installed in the extraction line to hold the extraction steam at approximately 10 lb. gauge and to prevent a return flow of steam to the turbine.
9. The turbines will operate successfully with full steam flow to atmosphere.
10. The units will cover the entire range of conditions as listed above under automatic control of the speed governor.
11. The steam flow to the throttle is guaranteed not to exceed the amounts listed in Part V for the given loads when operating with steam at 375 lb per sq. in. gauge at throttle, 175°F superheat, and 1 lb. per sq. in. absolute at the turbine exhaust flange. The guaranteed steam flows include the necessary steam for sealing the packing glands, and includes the electrical losses for the exciter fields and rheostats.

**THE BOSTON METALS CO.**

313 E. Baltimore St. Baltimore 2, Md.
ELGIN 5-5050 LEXINGTON 9-1900

Circle 514 on Reader Service Card

# CHECK WITH WAGNER FIRST!

**Thousands of new and "Certified Rebuilt" Motors & Generators in stock—up to 1000 H.P.**
**OUR 54th YEAR**

### A. C. MOTORS—60 CYCLE

| HP | Mfr. | Type | Volts | Speed |
|---|---|---|---|---|
| 900 | Whse. (2) | Sq. Cage | 2300 | 1800 |
| 750 | G.E. | Slipring | 2300 | 514 |
| 700 | Whse. | Slipring | 2300/4000 | 1200 |
| 600 | G.E. | Synch. | 480 | 900 |
| 600 | Elliott (2) | Sq. Cage | 2300 | 900 |
| 500 | Allis Ch. | Slipring | 2300/440 | 600 |
| 400 | G.E. | Sq. Cage | 440 | 1200 |
| 400 | Whse. | Sq. Cage | 2200 | 514 |
| 400 | Marathon (2) | Sq. Cage | 2200 | 3600 |
| 400 | G.E. | Slipring | 2300 | 514 |
| 400 | El. Machy. | Synch. | 2300/4000 | 400 |
| 350 | Br. Boveri b.b. | Sq. Cage | 4800/440 | 720 |
| 350 | G.E. | Sq. Cage | 2300 | 1800 |
| 350 | Allis Ch. | Slipring | 2300/4000 | 600 |
| 350 | G.E. | Slipring | 220/440 | 900 |
| 300 | Allis Ch. | Synch. | 440 | 360 |
| 300 | Whse. | Synch. | 440 | 1200 |
| 300 | G.E. | Slipring | 220/440 | 514 |
| 250 | G.E. | Sq. Cage | 2200/440 | 1200 |
| 250 | G.E. | Sq. Cage | 2200/440 | 450 |
| 250 | Gen. Elec. | Sq. Cage | 440 | 2000 |
| 250 | G.E. TEFC | Sq. Cage | 440 | 1200 |
| 250 | Whse. | Sq. Cage | 2300/410 | 600 |
| 250 | Whse. (4) | Slipring | 2300/440 | 600 |
| 200 | G.E. b.b. | Sq. Cage | 220/440 | 720 |
| 200 | G.E. | Slipring | 220/440 | 450 |
| 200 | G.E. | Slipring | 440 | 600 |
| 200 | G.E. | Slipring | 2200 | 900 |
| 200 | Reliance b.b. | Sq. Cage | 220/440 | 1800 |
| 200 | Allis Ch. | Slipring | 2300/440 | 720 |
| 150 | Whse. XP | Sq. Cage | 440 | 3600 |
| 150 | G.E. (4) | Slipring | 2200/440 | 600 |
| 150 | G.E. (2) | Sq. Cage | 2200/440 | 1800 |
| 150 | Whse. | Slipring | 220/440 | 1200 |
| 150 | G.E. | Sq. Cage | 2300 | 900 |
| 125 | A.C. TEFC | Sq. Cage | 220/440 | 1800 |
| 125 | El. Machy. (2) | Synch. | 220/440 | 400 |
| 125 | G.E. TEFC | Sq. Cage | 2200 | 3600 |
| 125 | Al. Ch. TEFC | Sq. Cage | 220/440 | 600 |
| 125 | G.E. (2) | Slipring | 220/440 | 514 |
| 100 | Whse. TEFC | Sq. Cage | 220/440 | 1200 |
| 100 | Al. Ch. TEFC | Sq. Cage | 2200 | 1800 |
| 75 | G.E. b.b. (8) | Sq. Cage | 220/440 | 1200 |

### D. C. GENERATORS

| KW | Mfr. | Type | Volts | Speed |
|---|---|---|---|---|
| 500 | Gen. Elec. | CY-321 | 250/350 | 1200 |
| 200 | Gen. Elec. | BC | 250 | 1450 |
| 100 | Delco b.b. | 7406 | 120/240 | 1750 |
| 75 | Allis Ch. b.b. | KB-146L | 125 | 1800 |
| 75 | G.E. b.b. | CD | 250 | 1750 |
| 60 | Ideal | D | 125 | 1189 |
| 60 | G.E. b.b. | CD | 600 | 1750 |
| 50 | G.E.(2) | CD-1129 | 250 | 1200 |

### D. C. MOTORS

| HP | Mfr. | Type | Volts | Speed |
|---|---|---|---|---|
| 250 | Cr. Wh. | 161-H | 230 | 1150 |
| 200 | G.E. (2) | BC-38 | 230 | 1150 |
| 200 | Whse. b.b. | SK | 250 | 287/575 |
| 150 | Rel. TEFC b.b. | 2550-F | 230 | 850 |
| 150 | Whse. | SK-210 | 230 | 320/1000 |
| 125 | G.E. | CD-173 | 230 | 575/1150 |
| 100 | Elliott b.b. T.E. | JH-FE | 230 | 1150 |
| 100 | El. Dyn. b.b. (2) | 36-B | 230 | 450/1200 |
| 80 | Whse. dyn. b.b. | SK-123L | 250 | 1800/5000 |
| 75 | Whse. (3) | SK-160 | 230 | 550/1150 |
| 75/100 | Whse. | SK-191 | 230 | 300/900 |
| 60 | G.E. TEFC b.b. | CD-135 | 230 | 1150 |
| 50 | G.E. | BP-16 | 230 | 250/1000 |
| 50 | Century new | DN-514 | 230 | 1150/1750 |
| 40 | Whse. | SK-163 | 230 | 300/1200 |

### MOTOR-GENERATOR SETS

| KW | Mfr. | Input V | Output V |
|---|---|---|---|
| 600 | Allis Ch. | 440 AC | 250 DC |
| 500 | Whse. Synch. | 2300/4000 AC | 250 DC |
| 300 | Whse. (2) | 2300/440 AC | 250 DC |
| 200 | Gen. Elec.* | 220/440 AC | 125 DC |
| 125 | Gen. Elec.* | 2300/4000 AC | 250 DC |
| 125 | Whse. | 220/440 AC | 250 DC |
| 100 | Delco b.b. | 220/440 AC | 120/240 DC |
| 80 | Star b.b. Synch. | 220/440 AC | 250 DC |
| 75 | Whse. Synch. | 220/440 AC | 250 DC |
| 75 | G.E. | 220/440 AC | 125 DC |
| 50 | G.E. b.b. (3) | 220/440 AC | 250 DC |
| 35 | Reliance b.b. | 220/440 AC | 250 DC |

**Arthur Wagner Co.** Certified
MOnroe 6-7409
1435 W. RANDOLPH ST
CHICAGO 7, ILLINOIS

Circle 515 on Reader Service Card

## DIESEL GENERATOR SETS

1—1420 KVA F.M. 3/60/2400 1945
1— 625 KVA Superior 3/60/2300, 1950
1— 375 KVA Caterpillar Portable 3/60/2300, 1953
1— 375 KVA GM—8—268—3/60/480, 1945
1— 250 KVA F.M. 3/60/220/440/300 RPM, 1947
1— 187 KVA G.M. Portable 3/60/220/440, 1953
1— 156 KVA Cummins Portable 3/60/220/440, 1956
1— 125 KVA Cummins Portable 3/60/220/440, 1956
1—118 KVA F.M. 3/60/2300/360 RPM
1— 75 KVA Hercules Portable 3/60/220/440
2—37½ KVA G.M. Portable 3/60/220/440
20—12½ KVA Willys Gas 1/60/115/230
10—6.25 KVA Ford Gas 1/60/115

**THE O'BRIEN MACHINERY CO.**
1915 W. CLEARFIELD STREET
PHILADELPHIA 32, PA.

Circle 516 on Reader Service Card

## POWER EQUIPMENT

6000 KW, G.E. Cond. Turbo-Generator 3/60, 2400 V, 3600 RPM, 200 PSI
5500 KW, G.E. N.C. Turbo-Generator 3/50, 2300 V, 3000 RPM 600 PSIG 650°TT, 150# B.P.
1500 KW, G.E. Cond. Extr. Turbo-Gen. 3/60, 2400 V, 3600 RPM 200/400 PSIG, 750°TT, 15# Extr.
1000 KW, Worth-Moore, Cond. Ext. Turbine, 3/60, 245/490V, 3600 RPM, 130-300# I.P., 10# Ext.
640 HP, B & W, Water Tube Boilers (4) 200# Sectional Header
1500 KW, West. Motor Generator Sets (2) 3/60, 2300/4600 Volts A.C.— 250 volts D.C., 514 RPM

**BREW, WOLTMAN**
& COMPANY, INC.
30 CHURCH ST., NEW YORK 7, N.Y.

Circle 517 on Reader Service Card

*PROMPT, EFFICIENT*

## DIESEL ENGINE *MAINTENANCE SERVICE*

**AT YOUR INSTALLATION SITE OR IN OUR PLANT!**

On-the-job repair, overhaul or periodic maintenance for minimum downtime by our expert servicemen available on call. Complete stock of replacement parts for all makes of diesel engines.

Inquire about our **UNIT EXCHANGE PLAN** that avoids costly downtime and can save you money. Applies to Fairbanks-Morse model 38D, Cleveland models 278A and 268A, GM Electro-Motive Division model 567.

*Write for full information on all maintenance services*

**A. G. SCHOONMAKER** *Company, Inc.*
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# UNUSED—ASSEMBLED—NEW

## IN ORIGINAL MANUFACTURER'S PACKING CRATES

**BOILERS (Package type)**

B&W—60,000 lbs./hr.—475 psig., 740°TTF, oil fired (shipped intact as one integral unit)
B&W—122,500 lbs./hr.—635 psig., 850°TTF, oil fired (unassembled)

**TURBOGENERATORS**

4800 KW GE Turbine—Gen Set, Cond 410psi, 725°TTF, 28.5 Hg exh, 3/80.3/2700V PF 1.0—New
1800 KW GE Turbine—Gen Set, Cond 410psi, 725°TTF, 28.5 Hg exh, 3/60/1735 V PF 0.8—New
1000 KW GE Turbine—Gen Set, Cond 200psi, 600°TTF, 28.5 Hg exh, 3/60/2400V PF 0.8

**STEAM TURBINES**

1000 SHP GE Cruising Cross Compound, 525psi, 825°TTF, 81psi exh, 10,119/350 RPM with Falk reduction gears—New
3000 SHP GE HP Main propulsion turbine 410psi, 9040RPM, 725°TTF } 1 Set—New
3000 SHP GE—LP Main propulsion turbine 40psi, 9040RPM
11,550 SHP GE HP 12 Stage Cross compound turbine 525 psig, 825°TTF 5870RPM } 1 Set—New
13,450 SHP GE LP 48psig, 4714RPM with Westgh speed decreaser gear assy.
394 HP Worthington-Moore, Non-Cond, Form #82R, 310psig, 650°TTF, 2psi-exh, 3560RPM

**PUMPS, CENTRIFUGAL (Motor driven)**

283 GPM @ 375'TDH, Ingersoll Rand—2GT, w/60HP 3525RPM 3/60/220/440V (Used)
275 GPM @ 635'TDH, Ingersoll Rand—2GT, w/75HP 3525RPM 3/60/2300V (Used)
200 GPM @ 1300'TDH, Ingersoll Rand—1½CNTA, w/Base, Motor optional

**PUMPS, CENTRIFUGAL (Turbine driven)**

460 GPM @ 750psi discharge, Worthington, w/350HP turbine, 575psi, 4900RPM—New

**BLOWERS, TURBO-CENTRIFUGAL**

20,000 CFM @ 17"WC, Westinghouse, Vaneaxial, w/Turbine, 82.5HP, 375psi, 10psi—exh, 4625RPM—New
24,000 CFM @ 28"WC, Sturtevant Co, Rexvane, w/Turbine, 191HP, 400 psi, 10psi—exh, 3525RPM—New
43,000/50,000 CFM @ 8"/11"WC, Sturtevant, Turbovane, w/Turbine 86/141HP, 400psi, 10psi —exh, 4900/5870RPM—New

## WABASH POWER EQUIPMENT CO.

**9750 SKOKIE BLVD., CHICAGO (Skokie), ILLINOIS**

TEL. OR. 3-8118

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# TRANSFORMERS

**BOUGHT · SOLD · RENTED**

**REWOUND · RE-DESIGNED**

**MANUFACTURED**

*Ask for our Stock List*

**For Sale**

3—2500 KVA G-E 69000—2300Y
3—2500 KVA G-E 69000—2400/4160Y
3—2500 KVA G-E 69000—7200/12470Y
4—2500 KVA W-H 34500—2400/4800
3—1500 KVA G-E 69000—2300Y
3—1500 KVA G-E 69000—2400/4160Y
3—1500 KVA G-E 69000—7200/12470Y

**THE ELECTRIC SERVICE CO., 5322 Hetzel St., Cincinnati 27, Ohio**
*"America's Exclusive Independent Transformer Service Shop"*

Circle 520 on Reader Service Card

**AUTOMATIC and MANUAL**
**Gas or DIESEL GENERATOR UNITS**
Complete Switchboard Design and Construction
USED & REBUILT EQUIPMENT
**UNIVERSAL POWER ENGINEERING CO.**
382 Wayne St. Jersey City, N. J.
Phone: DElaware 2-8300

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## BOILERS

FOR SALE, SPECIALLY
**BABCOCK & WILCOX**
SECTIONAL HEADER
**ARG CHEMICAL MACHINERY**
507 Fifth Avenue, New York 17, N. Y.

Circle 523 on Reader Service Card

## TRANSFORMERS

1—10667 kva G.E. 3/60/66000/11500
1— 6667 kva Westinghouse 3/60/115,000Y/13750
1— 6000 kva G.E. 3/66000/2400/4160Y
1— 2000 kva Nia. Askarel, 3/13800/4160Y/2400
3— 1500 kva Wagner, 1/60 cy. 6900—2400/4160Y
5— 1000 kva Standard, 1/44000/6900
5— 1000 kva Standard, 1/66000/4160Y/2400
3— 1000 kva Standard, 1/34400/48
3— 833 Allis Chalmers 1/60/12,000-480
3— 333 kva G.E., 25 cy, 2400/4800—240/480
3— 200 kva Westinghouse, 4800—240x480
3— 100 kva G.E., 2400/4160Y—120x240
5— 75 kva G.E., 2400/4160Y—120x240
5— 50 kva WEST COP, 4160/7200Y, 120/240

**ERIE ELECTRIC CO., INC.**
28 Mechanic St. Buffalo 2, N. Y.

Circle 522 on Reader Service Card

## SURFACE CONDENSERS

*Practically New*

4500 Sq. Ft. Westinghouse
3525 Sq. Ft. C. H. Wheeler
Other Sizes

Also New Air Ejectors

**CHARLES WEAVER, INC.**
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Detroit 35, Michigan
Phone: BRoadway 3-1900

Circle 524 on Reader Service Card

**NEW EQUIPMENT FROM THE UNCOMPLETED**

# BATTLESHIP U. S. S. KENTUCKY

***Installed but never used***
***Built of finest materials***

**WESTINGHOUSE 1250 K.W. TURBO-GENERATORS**

(4)—Westinghouse—440/3/60—850#—540 lbs. working pressure. Complete with condensers, circulating pumps, etc.

**MAIN CONDENSERS**

Mfg. by Foster-Wheeler—23,500 sq. ft. cooling surface—40,500 GPM circulating water—total tubes 8,976, or cupro-nickel, as follows: (550) each ⅝" x 0.066 and (8416) each ⅝" x 0.049. Monel water boxes.

**BOILERS**
**7 B&W EXPRESS TYPE**

Design pressure 634# — operating pressure 565# — temp. 850°F. Oil fired — separately fired superheaters. *Capacity: 210,000 lb.* steam/hr. ideal for testing where large quantities of steam are required, giving excellent control from separately fired superheaters.

**LARGE DEAERATING FEED HEATERS**

Monel construction—spray type—capacity 480,000 lbs./hr.—vent condenser—single pass —heating surface 174 sq. ft.—all Monel construction.

**GE HIGH AND LOW PRESSURE MAIN PROPELLING TURBINES**

Will sell separately for testing, wind tunnel or similar work. (2) high pressure—24,400 HP—12 impuse stages—4909 RPM—working pressure 540 lbs.—825°F. (2) low pressure—28,600 HP — 3913 RPM — working pressure 49 lbs. steam—424°F—2-6 stages of impulse.

**THE BOSTON METALS CO.**
313 E. Baltimore St., Baltimore 2, Md.
ELIGIN 5-5050 — LEXINGTON 9-1900

Circle 525 on Reader Service Card

# OPPORTUNITIES!

**In**

*New and used equipment recently released from service by a number of electric and gas utility companies*

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**SUBSTATION EQUIPMENT**
**TRANSMISSION LINE MATERIALS**

*Send for new list . . . to*
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APPARATUS EXCHANGE
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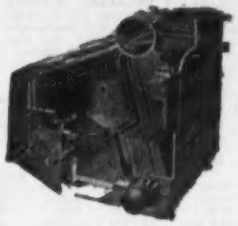
Circle 526 on Reader Service Card

## BOILERS NEW UNASSEMBLED



| # Steam/hr. | Key | PSI | Temp. |
|---|---|---|---|
| 122,300 | DF | 565 | 850 |
| 121,650 | DF | 565 | 850 |
| 60,000 | SF | 435 | 750 |
| 74,000 | H | 280 | 500 |
| 55,000 | A | 240 | — |

DF Double Furnace, SF Single Furnace (illustrated), bent water tube boilers w/economizers and superheaters, B & W's and
A Foster Wheelers.

Header type, straight tube, B & W.

H 3 drum, single furnace, Wickes.

**Pelnik-Loconti Industrial Supply, Inc.**

315 Oriskany St., Yorkville, N.Y.

Utica, N. Y. Ph. RE 6-4621, RE 2-4513

Circle 528 on Reader Service Card

## WANTED

Boiler parts, tubes and accessories that would go with above boilers. See above advertisement.

Pelnik-Loconti Industrial Supply Inc.

Circle 529 on Reader Service Card

MUST BE SOLD AT ONCE!

## 300 H.P. BOILER

Keeler Boiler. Type C.P. Water Tube. Serial No. 11157. Std. No. NB 825. S.W.P. 160. B.H.S. 2690. W.W.H.S. 310. With Automatic Feed Stoker. Used but in good condition.

*For low, low price, Write, Wire or Phone*

**MR. L. ADLER**

**CLEVELAND WRECKING CO.**

1400 Harrison Ave., Cincinnati 14, O.

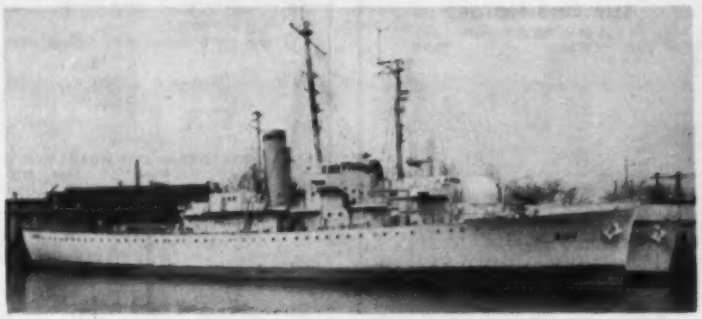
Phone WAbash 1-1160

Circle 527 on Reader Service Card

## "SEARCHLIGHT" Can Help You!

When you want to buy or sell used or surplus new Power equipment and/or accessories, or have other business wants — advertise them in the SEARCHLIGHT SECTION for quick, profitable results!

## FOR SALE: Turbo-Electric Vessel "TAMPA"



### USE AS FLOATING POWER PLANT

***or remove boilers and main turbo-generator for use as stationary power source***

Power plant mfg by Westinghouse. Turbine: 3220 HP @ 3600 RPM—250 PSI—175° superheat — 28½" vacuum — 1½" back pressure. Water rate: 11.2 lbs/KW hr. Generator: 2600 KVA—2300 volts—3 phase 60 cycle—.8 PF—655 amps—3600 RPM—serial no. 4954746. Boilers: 2—B&W watertube—shop no. MB-1137—crossdrum sinuous header type. Total heating surface 3514 including superheater—WP 250 lbs—175° superheat. Oil burning; furnace volume 437 cu ft. Units complete with all auxiliaries such as fuel oil service pumps; oil heaters, etc. Also condenser & circulating pump; condensate pump; switch gear. All equipment in place. For immediate inspection.

## The Boston Metals Company

313 E. Baltimore St. — LExington 9-1900 — Baltimore 2, Md.

Circle 530 on Reader Service Card

## LIQUIDATION MODERN BOILER PLANT

**5—B & W 70,000#/hr Boilers, 600 psi. (1953)**
1—B & W 80,000#/hr Boiler, 600 psi. (1946)
1—Graver Water Softening Plant.
1—Graver Water Treating Plant.
1—Carrier Cent. Blower, 3 stg., 38,300 cfm.
1—Carrier Cent. Comp., 6 stg., 9370 cfm.
1—Carrier Cent. Comp., 3 stg., 5535 cfm.
6—B. J. Cent. Pumps, 7000 gpm, 120' head.
1—D. H. Cent. Pump, 4500 gpm, 116' head.
1—Worth. Cent. Pump, 2750 gpm, 100' head.
2—A. C. Cent. Pumps, 2250 gpm, 165' head.
1—I.R. Cent. Pump, 1200 gpm, 300' head.
1—Pac. Cent. Pump, 1200 gpm, 290' head.
2—Lummus Surface Condensers, 6100 & 2250 sq. ft., Admiralty tubes.

*WIRE PHONE WRITE*

## BRILL EQUIPMENT COMPANY

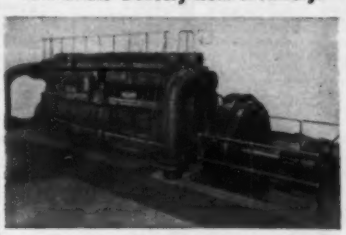
DESTREHAN, LA. Tel: Norco 6571

Home Office:
35-51 Jabez St., Newark 5, N. J.
Tel: Market 3-7420

Circle 531 on Reader Service Card

## DIESEL ENGINE GENERATOR SETS

**Immediate Delivery from Inventory!**



Any voltage; 50 or 60 cycle. Available in stationary, mobile or portable model. Following listing is only partial.

1420 kva Fairbanks-Morse model 38D—8⅛ (photo above)
1375 kva General Motors model 278A
1250 kva General Motors model 567
938 kva General Motors model 567
625 kva General Motors model 278A
625 kva American Locomotive Co. model 539
412 kva Worthington model CC
375 kva General Motors model 268A
312 kva General Motors model 268A
250 kva General Motors model 268A

**A. G. SCHOONMAKER Company, Inc.**

Foot of Spring St., Sausalito, Cal. Edgewater 2-1490
50 Church St., New York 7, N. Y. Digby 9-4351

Circle 532 on Reader Service Card

# ELECTRICAL POWER EQUIPMENT

## SLIP RING MOTORS

3 ph 60 cy 220 or 440 volts

| HP | RPM | MAKE | TYPE |
|---|---|---|---|
| 1500 | 514* | Al.-Ch. | Mill Type |
| 1300 | 360* | Al.-Ch. | Mill Type |
| 900 | 180* | Al.-Ch. | Mill Type |
| 600 | 1800* | Gen. Elec. | M-63158, Dppf. New |
| 500 | 1200 | Gen. Elec. | M-63452, Dppf. |
| 400 | 720 | Gen. Elec. | MT-357Y |
| 350 | 900* | West. | CW |
| 350 | 1800* | Al.-Ch. | ARYW (2) |
| 300 | 1800 | Cr.-Wh. | BR |
| 300 | 600 | Gen. Elec. | I-M-17A |
| 300 | 600* | F.-Morse | HV-H300D, BB |
| 300 | 450 | Gen. Elec. | I-M, 2 or 3 brg. |
| 250 | 720* | Gen. Elec. | I-M-17A |
| 250 | 600* | West. | CW |
| 250 | 600* | West. | CW, 2 or 3 brg. |
| 200 | 600* | Gen. Elec. | I-M-16 |
| 200 | 600 | West. | CW-1000 (2) |
| 150 | 1800 | Cr.-Wh. | Size 50-S |
| 150 | 720 | Gen. Elec. | MT-5428 |
| 150 | 720 | Gen. Elec. | I-M |
| 150 | 720 | Al.-Ch. | ANY |
| 150 | 514* | Gen. Elec. | M-566 |
| 150 | 514 | Wagner | BR |
| 150 | 400 | Gen. Elec. | I-M-17 |
| 125 | 1800 | Al.-Ch. | ARY-226 (2) |
| 125 | 600 | Gen. Elec. | I-M-18A |
| 100 | 1800 | Gen. Elec. | I-M-13A |
| 100 | 900 | Gen. Elec. | MT-356 |
| 75 | 1800 | West. | CW-753 |
| 75 | 1200 | West. | CW-170-2C, TEFC, BB |
| 75 | 1200 | Gen. Elec. | I-M-13 |

*2200 volts or higher

## SQUIRREL CAGE MOTORS

3 ph. 60 cy. 220 or 440 volts
(*2200 volts or higher)

| HP | RPM | MAKE | TYPE |
|---|---|---|---|
| 1250 | 3600* | Al.-Ch. | ANX |
| 800 | 1800 | West. | CS34C |
| 600 | 600* | West. | CS-14-C15 Dppf (2) |
| 500 | 1200 | G.E. | I-K |
| 400 | 1800* | L. Allis | BB, Sppf. |
| 400 | 1800 | West. | BB. Dppf. |
| 400 | 1200 | G.E. | KTP-565 |
| 350 | 3600 | Cr.-Wh. | SC, Dppf. |
| 300 | 1200 | G.E. | KT-559, Dppf. |
| 300 | 600* | West. | CS-39A |
| 300 | 600* | West. | CS-1002 |
| 300 | 400 | Elliott | Design 40T03 |
| 250 | 1800 | G.E. | KT-559 |
| 250 | 1800 | West. | CS-81208, TEFC, Xpf. |
| 250 | 1200 | G.E. | KTP-561 |
| 250 | 1200 | G.E. | I-K |
| 250 | 720 | West. | CS-1000 |
| 200 | 1800* | G.E. | I-K-12B 88B |
| 200 | 1800 | West. | CRP-5818, Dppf. |
| 200 | 1200 | G.E. | K-63348, Dppf. |
| 200 | 900 | West. | CS-8748, 88B |
| 200 | 900* | West. | CS-930A |
| 200 | 720* | Al.-Ch. | AN-37G |
| 200 | 720 | G.E. | KP-5648 |
| 200 | 600 | West. | CS-1010 |

## MOTOR GENERATOR SETS

| KW | Make | Motor A.C.V. | Generator D.C.V. |
|---|---|---|---|
| 1000 | West. | 4160 | 250 |
| 600 | G.E. (3 unit) | 2300/440syn. | 125/250 |
| 500 | West. | 2300/440syn. | 125/250 |
| 400 | Al.-Ch. | 2300/440syn. | 125/250 |
| 300 | West. | 2300/480syn. | 250 |
| 200 | Rel. | 2300/440syn. TS | 500 |
| 200 | G.E. | 2300/440syn. TS | 250/275 |
| 200 | Ridgwy | 2300syn. | 250 |
| 150 | Al.-Ch. | 220/440/220 | 250 |
| 150 | West. | 2300/440/220syn. | 125/250 |
| 125 | West. | 2300/480syn. | 250 |
| 125 | G.E. | 2300/480syn. | 250 |
| 100 | West. | 2300/4000syn. | 250/275 |
| 100 | G.E. | 2300/4160syn. | 250 |
| 100 | G.E. | 2300/4000 | 125 |
| 100 | El-My. | 230/440syn. | 125 |
| 75 | West. | 2300/440/220 | 250 |
| 60 | G.E. | 230/440 | 250 |
| 50 | El-My. | 220/440 | 250 |
| 50 | G.E. | 220/440 | 250 |
| 50 | West. | 200/400 | 125 |
| 35 | West. | 220/440 | 250 |
| 35 | G.E. | 220/440 | 250 |
| 30 | G.E. (2) | 220/440 | 125 |
| 25 | G.E. | 220/440 | 125 |
| 15 | Ideal | 220/440 | 125 |

## TRANSFORMERS

***Special Offer — Like New***

3—1250 KVA Allis Chalmers Class OA Oil filled Sgl ph 60 cy 34,400 Volt primary, 480 volt secondary with taps, manufactured 1955.

Write for current complete stock lists on electrical power equipment you need or send your list of surplus and used equipment for our offer.

**Phone CAnal 6-2900**

**CHICAGO Electric Co.**

1320 W. CERMAK ROAD • CHICAGO 8, ILL.

Circle 533 on Reader Service Card

# *37 Years Dependable Service*

## SLIP RING MOTORS 3 Ph., 60 Cy.

| H.P. | Volts | Make | Speed |
|---|---|---|---|
| 500 | 4000/2300 | G.E. | 600 |
| 450 | 4000/2300 | G.E. | 1200 |
| 400 | 4000/2300 | Whse. | 720 |
| 300 | 4000/2300 | G.E. | 720 |
| 300 | 2300 | G.E. | 900 |
| 300 | 440 | G.E. (hoist) | 600 |
| 300 | 440 | Whse. | 3600 |
| 235 | 4000/2300 | G.E. (hoist) | 600 |
| 200 | 2300 | G.E. | 600 |
| 200 | 2300/440 | G.E. | 720 |
| 150 | 320/440 | Whse. | 720 |
| 125 | 2300 | G.E. | 600 |

## AC GENERATORS or SYN MOTORS, 60 Cy.

| H.P. | Volts | Make | Type | R.P.M. |
|---|---|---|---|---|
| 400 | 2300 | G.E. | TS | 1800 |
| 400 | 2300/440 | G.E. | ATI | 720 |
| 300 | 440/220 | G.E. | TS | 450 |
| 300 | 2300/440 | G.E. | TS | 1200 |
| 200 | 440 | G.E. | TS | 600 |
| 150 | 440/220 | Whse. | G | 1200 |
| 125 | 440/220 | Whse. | HR | 600 |

## SQUIRREL CAGE MOTORS

| | | | | |
|---|---|---|---|---|
| 500 | 2300/4000 | Elliott | SC | 1800 |
| 400 | 2300 | G.E. | FT | 3600 |
| 400 | 2300/4000 | G.E. | K | 1200 |
| 350 | 2300/4000 | G.E. | SEDP | 3600 |
| 250 | 2300/4000 | G.E. | K | 600 |
| 300(2) | 2300 | G.E. | FT | 3600 |
| 300 | 2300/4000 | L. Allis. | FS | 1800 |
| 300 | 2300/440 | G.E. | SEDP | 1200 |
| 300 | 2300/4000 | Cont'l. | Spl.-Prf. | 720 |
| 300 | 2300/400 | G.E. | KT | 600 |
| 250 | 2300/4000 | G.E. | K | 720 |
| 200 | 2300 | G.E. | KT | 1800 |
| 200 | 2300 | Cont. | TEFC | 3600 |
| 150 | 440 | Whse. | X-pf. | 3600 |
| 150 | 440/220 | Cont'l. | X-pf. | 1800 |
| 150 | 440/220 | G.E. | TEFC | 720 |
| 150 | 2300/440 | | KT | 600 |
| 150 | 2300/440 | G.E. | TEFC | 3600 |
| 125 | 2300/440 | G.E. | FT | 1200 |
| 100(2) | 4000/2300 | L. Allis. | K | 600 |
| 100 | 2300 | Cont'l. | OX | 1200 |
| 60(2) | 440 | Cont'l. | X-pf. | 1800 |

## CIRCUIT BREAKERS, 3 Pole

4—1600 Amp., DA-50, Whse., 600 V., Air
1—600 Amp., Al. Chal., 15 KV, Outdoor
6— 400 Amp., R. Smith, 7.5 KV, Sol. oper.
1— 400 Amp., R. Smith, 7.5 KV, outdoor, New

## D. C. MOTORS

| H.P. | Volts | Make | Type | Speed |
|---|---|---|---|---|
| 150 | 230 | El. Dyn. | B/brg. | 600 |
| 60/75 | 230 | G.E. (new) | CD | 460/1500 |
| 90 | 230 | G.E. | CD | 1750 |
| 50 | 230 | G.E.(4) | CD | 1150 |

## MOTOR GENERATOR SETS

| KW | Make | Input.. AC | Motor Type | Output V.. DC |
|---|---|---|---|---|
| 300 | Whse. | 4150/440 | Syn. | 250/125 |
| 150 | G.E. | 440/220 | Syn. | 250 |
| 125 | G.E. | 440/220 | Sq. Ca. | 125 |
| 100 | G.E. | 2300/440 | Syn. | 250 |
| 75 | Cr. Wh. | 440/220 | Sq. Ca. | 250/125 |
| 70 | El. Dyn. | 440 | Sq. Ca. | 70 |
| 65 | G. E. B | 2300/440 | Sq. Ca. | 250 |

## TRANSFORMERS 60 Cy.

1—500 kva, Al Ch. 2400/4160Y—600 volts, 3 ph
2—500 kva, G.E., 12800—240/480 V.
2—200 kva, Mol., 12,800—2300 V.
2—333 kva, G.E., 13,800—2400 V.
3—333 kva, G.E., 2400—240/120 V.
3—200 kva, G.E., 12,800—480 V.
3—200 kva, G.E. 4150—480/240 V.
3—167 kva, Whse., 4150—480 V.
3—150 kva, Al. Ch., 2400—220 V.
2—150 kva, G.E., 13,200—2300 V.
3—100 kva, Whse., 4800/2400-240/480 V., Dry
3—100 kva, G.E. 2400—120/240 V., Pyr.

## GASOLINE—ENGINE GENERATOR SETS

3—37½ kva, 1800 R, 220 V 3/60, Cont'L, 6 cyl.

*only partial listing*

**STEPHEN HALL & CO.**

**HARRY J. RICE, Pres.**

**625 ADAMS ST., HOBOKEN 2, N. J.**

Circle 534 on Reader Service Card

# NEW BOILERS FROM S.S. HAWAII

***NEVER USED***

# 8 B&W WATER TUBE BOILERS

*With Separately Fired Superheaters*

634 pounds working pressure—850° T.T.—6053 square feet generating surface. Capacity 158,000 pounds steam per hour. Capacity plus 20%—190,000 pounds steam per hour. Total dry weight 135,258 pounds. Units complete with burners, economizers, soot blowers, valves, controls, etc.

**DIMENSIONS:**

Overall width 11'
Height over drum 21'
Depth 15'

**THE BOSTON METALS CO.**

**313 E. Baltimore St., Baltimore 2, Md.**

**ELGIN 5-5050 — LEXINGTON 9-1900**

Circle 535 on Reader Service Card

## DIESEL ENGINE GENERATOR UNIT

575 HP, 600 RPM, Worthington Type DH-6 Diesel engine direct connected to 500 KVA—400 KW, 80% PF, 600 RPM, 3 phase 60 cycle, 240/139 volts Electric Machinery synchronous generator complete and equipped with exciter, switchboard with instruments, attached and unattached auxiliaries to the engine. Slightly used—practically new. Immediate delivery.

**UTILITIES MACHINERY CORPORATION**

**1965 East Sixth Street, Cleveland 14, O.**

Circle 536 on Reader Service Card

4—1250 KVA Transformers 6900/12000 Y 2300 V.
1—Elliot Deaerating Feed Tank—1000 gal. New, unused—Monel
1—De Laval Boiler Feed Pump—540# steam 675 GPM @ 725# pressure—New, Unused

**LEWON BROS.** 367 Bayshore, S.F. 24, Calif.
Phone AT 2-2726

Circle 537 on Reader Service Card

## *WANTED*

200 HP Boiler Scotch Marine Type with burner or without.

## *FOR SALE*

Iron fireman automatic coal burner overhead feed type complete with controls very good condition. Answer P.O. Box 351, St. Joseph, Mich.

Circle 538 on Reader Service Card

## SEARCHLIGHT Equipment Locating Service

***NO CHARGE OR OBLIGATION***

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used power equipment not currently advertised. (This service is for USER-BUYERS only).

How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment wanted on the coupon below, or on your company letterhead to:

***Searchlight Equipment Locating Service, c/o POWER,***

**P. O. Box 12, N. Y. 36, N. Y.**

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

*Searchlight Equipment Locating Service*
c/o POWER, P. O. Box 12, N.Y. 36, N.Y.

Please help us locate the following used equipment .....

.....

NAME .....

TITLE .....

COMPANY .....

STREET ..... CITY ..... 4/60

### TRANSFORMERS—60 CYCLE

| Qu | KVA | Make | Type | Phase | Voltages |
|---|---|---|---|---|---|
| 2 | 2000 | Moloney | TCR | 3 | 7200/6600-4160/3100 |
| 2 | 750 | G.E. | K | 1 | 4600-120/240 |
| 1 | 300 | Penna. | (Askarel) | 3 | 12470Y/7200-240 |
| 2 | 250 | G.E. | H Pyranol | 1 | 4800/2820Y/120/240 |
| 3 | 250 | West. | | 1 | 2300/4600-230/460 |
| 3 | 200 | G.E. | HSPZP | 1 | 2400/4160-240/480 |
| 3 | 200 | Amer. | CC | 1 | 4160/7200-240/480 |
| 3 | 75 | G.E. | KP | 1 | 2400/4160-120/240 |
| 3 | 50 | G.E. | H | 1 | 2400/4160-240/120 |
| 1 | 50 | Amer. | Abestal | 3 | 4160-120/208Y |
| 4 | 25 | West. | Hyperail | 1 | 2400/4160-120/240 |

### MOTOR GENERATOR SETS

| Qu | KW | Make | Speed | DC | AC |
|---|---|---|---|---|---|
| 1 | 75 | EM | 1200 | 250 | Syn. 220V. |
| 1 | 75 | G.E. | 1200 | 125 | 2300/4160 Syn. |
| 1 | 100 | West. | 1200 | 250 | 2300/4160Y Syn. |
| 1 | 175 | West. | 1200 | 125 | 4150 Syn. |
| 1 | 75 | G.E. | 1200 | 250 | 2300/4160Y SR |
| 1 | 400 | G.E. | 1200 | 250 | 440 Syn. |
| 1 | 300 | Al.-Ch | 1200 | 125/250 | Syn. 440V. |
| 1 | 1000 | West. | 720 | 600 | 2300/4160Y |

### ENGINE GENERATOR SETS

1—Hercules Gas HXE 62.5 KVA Westghe 2/60/480—1200

1—Wisconsin Gas (Air) PE-99 7.5 KVA Master 1 or 2/120—2200 r.p.m.

### SLIP RING MOTORS

| Qu | HP | Make | Speed | Type | Volts |
|---|---|---|---|---|---|
| 2 | 40 | West. | 600 | CW | 220/440 |
| 1 | 60 | G.E. | 1800 | MT | 220 |
| 1 | 60 | G.E. | 600 | MT546 | 440 |
| 1 | 75 | G.E. | 600 | IM | 440 |
| 1 | 150 | West. | 1800 | T.E.F.C. B.B. | 220 |
| 2 | 150 | Allis-Ch. | 1800 | AY-RW | 2300 |
| 1 | 200 | West. | 514 | CW | 440 |
| 1 | 250 | West. | 600 | CW | 440 |
| 1 | 350 | West. | 1800 | CW | 2300 |
| 1 | 450 | West. | 1800 | CW-4-30-9, | 220 or 440 |
| 1 | 500 | G.E. | 450 | MT | 2200 |
| 1 | 500 | G.E. | 1200 | M360Z | 2300/4160Y |

### D. C. MOTORS—230 VOLTS

| Qu | HP | Make | Speed | Type |
|---|---|---|---|---|
| 1 | 350 | G.E. | 1200 | Pedestal |
| 1 | 30 | G.E. | 1750 | 173 FR |
| 1 | 30 | West. | 600/1400 | SK-4G1543 |

### SQUIRREL CAGE MOTORS, 3 PHASE, 60 CYC.

1—300 HP, 1200, Allis. Chalmers, 2300/4160Y

1—275 HP, 1130 RPM G.E. Type KT 550HS 2200V

2—200 HP, 1790 RPM, G.E. Elec. KP, TEFC, 2300V

1—100 HP, 1775 RPM G.E. KTP-543 3 ph 60-440V.

1— 75 HP, 3600 RPM Cont. NP 505—440Y Exp. P

### MOTORS—SYNCHRONOUS—3 ph. 60 cy.

100 HP 900 RPM G.E. Form BL 2200V.

125 HP 600 RPM G.E. Type TS 2200 V.

125 HP 900 RPM G.E. Type TS 4800 V.

150 HP 3600 RPM G.E. Type TS Fr. 6547Y 2200 V.

150 HP 1800 RPM G.E. Type TS 220 V.

300 HP 720 RPM Elec. Machinery t.e.f.c. 2300 V.

325 HP 900 RPM West—2300 V.

400 HP 450 RPM Westinghouse Type HR 440 V.

FOR POWER
J.L. HEMPHILL & CO.
1603 54th STREET, NORTH BERGEN, N. J.
PHONE NEW YORK - LONGACRE 5-1227

Circle 540 on Reader Service Card

### BOILER

1—200 HP Kesler, type CP, 150 psi, stoker fired. 1945

### COAL PULVERIZERS

1—Kennedy Van Saun 7' x 9' air swept ball mill, integral gear drive.

1—Babcock & Wilcox 812E ball-ring pulverizer, air swept, 75 HP.

2—Raymond 3452 bowl mills, 125 HP, pract. UNUSED.

*WRITE FOR DETAILS*

PERRY EQUIPMENT CORP.
1422 N. 6th St., Philadelphia 22, Pa.
Phone: POplar 3-3505

Circle 541 on Reader Service Card

BOILERS
HI-PRESSURE
Complete Stock from 10-2,000 h.p.
Nation's largest inventory, New & Used
WABASH POWER EQUIPMENT CO.
9730 Skokie Blvd., Chicago (Skokie) Ill. OR 5-8118

Circle 542 on Reader Service Card

MOTORS • GENERATORS
TRANSFORMERS
NEW • REBUILT
ELECTRIC EQUIPMENT CO.
WORLD'S LARGEST INVENTORY
CALL COLLECT GL 3-6782
P.O. BOX 11 • ROCHESTER 1, N.Y.

Circle 543 on Reader Service Card

## CONVERSION & POWER EQUIPMENT

### M-G SETS—3 Ph. 60 Cy.

| Qu. | KW | Make | RPM | DC Volts | AC Volts |
|---|---|---|---|---|---|
| 1 | 4000/4800 | G.E. (2U) | 450 | 250/300 | 2300/4600 |
| 1 | 2500 | Whse. (3U) | 720 | 600 | 2300/4600 |
| 1 | 1750/2100 | G.E. | 514 | 250/300 | 2300/4600 |
| 1 | 2000 | G.E. | 514 | 600 | 2300/4600 |
| 1 | 1500 | G.E. | 720 | 600 | 6600/13200 |
| 1 | 1500 | Cr.-Wh. | 720 | 140 | 2300/4160 |
| - | 1250 | Whse. | 720 | 600 | 2300/4160 |
| 1 | 1000 | G.E. | 720 | 250 | 2300/4160 |
| 1 | 1000 | G.E. | 900 | 250 | 4000/6600 |
| 1 | 600 | A.C. | 1200 | 600 | 2300 |
| 1 | 500 | G.E. | 900 | 125/250 | 440 |
| 1 | 500 | G.E. | 900 | 250 | 2300/4600 |
| 1 | 500 | G.E. (new) | 1200 | 300 | 2300 |
| 1 | 400 | C.W. (3U) | 1200 | 125/250 | 2300 |
| 1 | 250 | G.E. | 900 | 125 | 440/4160 |
| 3 | 300 | G.E. | 1200 | 250 | 2300 |
| 1 | 300 | Whse. | 1200 | 600 | 2300/4160 |
| 1 | 200 | G.E. | 1200 | 250/275 | 440 |

### MERCURY ARC RECTIFIERS

| Qu | KW | Make | Type | DC Volts | AC Volts |
|---|---|---|---|---|---|
| 2 | 150 | G.E. | RF 20 | 245 | 208 |
| 3 | 150 | G.E. | 6RP | 275 | 2300/4160 |

### FREQUENCY CHANGER SETS

| Qu. | KW | Make | Freq. | Voltages |
|---|---|---|---|---|
| 1 | 5000 | G.E. | 60/50/60 | 11000/6600 |
| 1 | 2500 | G.E. | 25/62½ | 2300/2300 |

### TRANSFORMERS

| Qu. | KVA | Make | Type | Ph. | Voltages |
|---|---|---|---|---|---|
| 3 | 3333 | Whse. | OISC | 1 | 13800x2300 |
| 1 | 3000 | A.C. | OISC | 3 | 34500x2300 |
| 3 | 1000 | G.E. | OISC | 1 | 13800x460 |
| 3 | 500 | Mol. | OISC | 1 | 6600/11430x480 |

### TURBO GENERATORS

| Qu. | KW | Make | Description |
|---|---|---|---|
| 1 | 1000 | G.E. | Non Cond. 125#/5-15# B.P. 2300V. |
| 1 | 3000 | G.E. | Cond. 400#-750° 2400/4150V. |
| 1 | 4000 | G.E. | Cond. 400#-750° 2400/4150V. |

### A.C. MOTORS — 3 Ph. 60 Cy. Slip Ring

| Qu. | HP | Make | Type | Volts | Speed |
|---|---|---|---|---|---|
| 1 | 1750 | G.E. | M-529BS | 4800/2400 | 1800 |
| 1 | 1500 | G.E. | MT-6 | 4000/6600 | 1187 |
| 1 | 800 | Whse. | CW | 550 | 1776 |
| 1 | 800 | G.E. | MT-425 | 2200 | 450 |
| 1 | 600 | Whse. | CW-32D-15 | 440 | 1778 |
| 1 | 600 | Whse. | CW | 440 | 850 |
| 1 | 550 | Whse. (Unused) | CW | 440 | 252 |

### SQUIRREL CAGE

| | | | | | |
|---|---|---|---|---|---|
| 1 | 550/275 | Whse. | CR-1115 | 2300 | 450/900 |
| 1 | 500 | G.E. | FT-559Y | 2300 | 3600 |
| 2 | 500 | Whse. | CSP-583H | 440 | 3600 |
| 4 | 500 | Whse. | CR-1216 | 2200 | 500 |
| 2 | 450 | Elliott | 3910 | 2200 | 1185 |
| 1 | 400 | Whse. | CR-7151 | 4000/6600 | 3600 |
| 1 | 300 | Whse. | CR-100Z | 2300 | 600 |
| 1 | 300 | G.E. | KT-559A | 2200 | 1775 |

### SYNCHRONOUS

| | | | | | |
|---|---|---|---|---|---|
| 1 | 7000 | G.E. | TS-6487 | 2300/4600 | 360 |
| 1 | 3300 | G.E. | ATI | 2300/6600 | 600 |
| 2 | 1750 | G.E. | ATI | 2300 | 3600 |
| 1 | 1750 | G.E. | TS | 2300 | 900 |

RE-NU-BILT BY

## BELYEA COMPANY, INC.

43 Howell St., Jersey City 6, N. J.

Tel: OLDFIELD 3-3334

Circle 544 on Reader Service Card

## FOR SALE

675 HP COOPER-BESSEMER DUAL FUEL DIESEL-GAS. 500 KW. 3/60/2300V. COMPLETE.

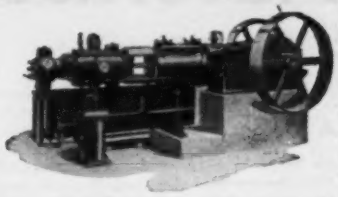
1275 HP COOPER-BESSEMER DUAL FUEL DIESEL-GAS. 900 KW. 3/60/2300 V. NEW 1953.

3000 KW GE CURTIS CONDENSING TURBO. 400# ISP. 3/60/2300 VOLTS. BUILT 1930. COMPLETE. EXCELLENT.

WHISLER EQUIPMENT CO.
1908 Railway Exchange Building
St. Louis 1, Mo.

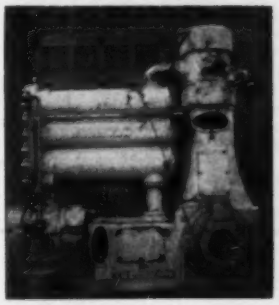
Circle 545 on Reader Service Card

## THE COMPRESSOR LINE



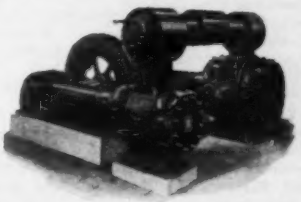
### HIGH PRESSURES

26.8 CFM 3000 psi Worth. V4A3
97 CFM 1500 psi 6½—3⅝—1⅝ x 7 CP TCB 3
113 CFM 2500 psi 6½—4½—1-11/16x9 IR ES3
119 CFM 5000 PSI Worth. V3A5
150 CFM 3000 psi 13½x12 Norwalk TRS4T
311 CFM 1500 psi 10½—7½—3½ x 15 IR ES3
351 CFM 350 psi 11-5x11 CP-TCB-2



505 c.f.m. 125 PSI Sullivan WJ3 Angle compound MVD 100 H.P. motor 3-60-220/440 Excellent Unit—In our plant.

PENNSYLVANIA Single Stage Duplex Synchronous Motor Driven Air Compressor. 2500 CFM @ 95#—800 H.P. This compressor used only (6) months by large oil refinery. 1—19x14 Pennsylvania DEI Duplex-single stage with 800 H.P. Elec. Mach. Syn. Motor 3-60-2300 1 PF. Can be seen on original foundation, Baltimore, Md.



3078 CFM Displacement, 80-110#, 180 RPM, 800 HP Motor. NEW 1945. 30/18 x 21 Ingersoll-Rand PRE-2 two stage, double acting, duplex, water cooled, heavy duty, horizontal, synchronous motor driven air compressor equipped with: Step control; Intercooler with safety valve; Mechanical force feed lubricator. DIRECT CONNECTED TO: 800 HP General Electric Type TS, 180 RPM, 80% power factor 3/60/2300/4000 volt engine type synchronous motor complete with MG set and 2300 volt starter.

VERY LATE — LOCATION WILKES BARRE, PA.

**For any size or make compressor try American Air.*

## AMERICAN AIR COMPRESSOR CORPORATION

Dell Ave. & Power St. North Bergen, N. J.

UNion 5-4848

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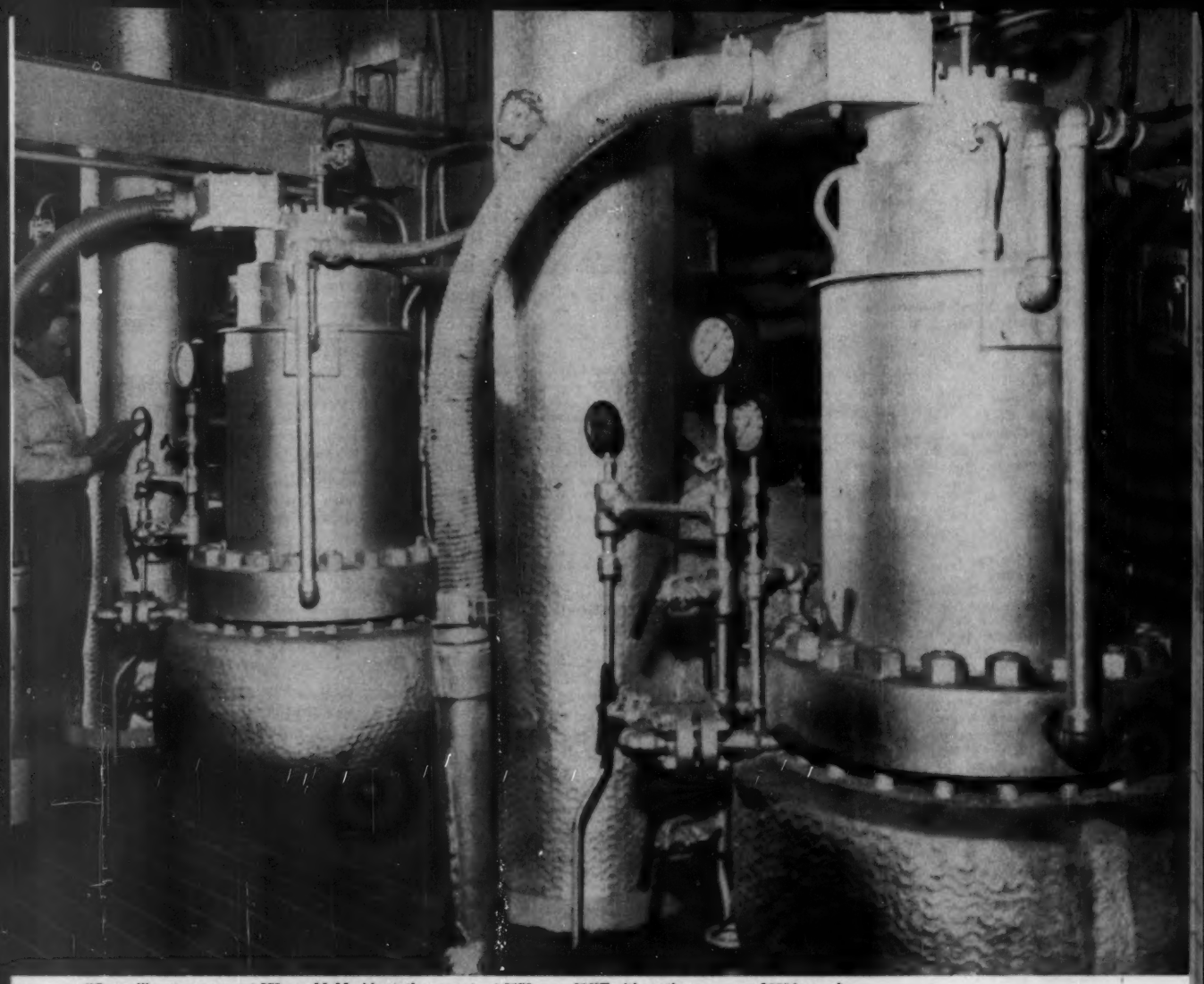


"Canned" motor-pumps at 275-mw McMeekin station operate at 6270 gpm, 652°F with suction pressure of 2536 pounds.

# Westinghouse canned motor-pumps help McMeekin station post nation's best heat rate

South Carolina Electric and Gas Company's Silas McMeekin station* recently recorded an annual heat rate of *9093 Btu* per net kwhr. This is the *number one* efficiency rating for the whole country in the Federal Power Commission's latest "Steam-Electric Plant Annual Production Expenses" report.

With two Combustion Engineering controlled circulation boilers furnishing the entire steam supply, the three Westinghouse "canned" motor-pumps installed on each boiler were important factors in this plant's exceptional efficiency rate.

- In operation since the second quarter of 1958, no pump has had to be opened for inspection or repair.
- The pump and motor casings completely enclose the pump shafting . . . eliminating conventional shaft seals and power-consuming seal injection systems.
- Watertight Inconel can encases stator . . . windings are dry and clean for years of trouble-free operation.
- Water lubricated bearings show maximum reliability and minimum wear characteristics.

To learn how Westinghouse "canned" motor-pumps will improve efficiency of *your* controlled circulation boiler, call your Westinghouse sales engineer, or write Westinghouse Electric Corporation, Atomic Equipment Department, P.O. Box 217, Cheswick, Pa. J-57023

*Gilbert Associates, Consulting Engineers

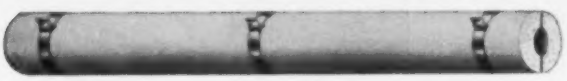
YOU CAN BE SURE...IF IT'S Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV ALTERNATE FRIDAYS

For more facts circle 368 on Reader Service card, p 133

# K&M ZEBRA

## THE YEARS-AHEAD DEVELOPMENT IN PIPE INSULATION!



3 times faster to apply than 2-layer sectional insulation, new "K&M" ZEBRA is a low, medium and high-temperature multi-layer sectional-type thermal insulation. It's as rugged as it is speedy. Its deflection at breaking point is 2 to 4 times that of ordinary insulation. That's why breakage during installation practically disappears. There's a new ease of handling, too. No skin irritation. No skin penetration by ragged projections. "K&M" ZEBRA is smooth-surfaced. And, too, it's easy to cut and fabricate . . . practically dust free. Get more information on this exciting, new development in pipe insulation. Write to us today for more information.

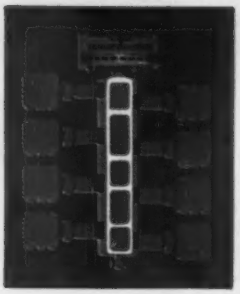
*• For temperatures of 200°F. to 1200°F. • Withstands shock and heat without warping or cracking. • Made of calcium silicate—asbestos fiber bonded felts. • Can be re-used . . . can be dismantled and re-applied. • Available in wide range of sizes and thicknesses. • Tested by an independent testing laboratory.*

K·M
BEST IN ASBESTOS

**KEASBEY & MATTISON**
COMPANY • AMBLER • PENNSYLVANIA

**For more facts circle 202 on Reader Service card, p 133**

# WILL YOUR NEXT BALANCED OPPOSED COMPRESSOR HAVE ALL OF THESE "HIDDEN VALUES"?



No, it won't! Even if you choose a Worthington compressor, you'll get only 23 of the 24 "hidden values" pictured below. (Just to pique your interest one is fictitious. For identification of the phony feature, see page 265.)

Compressors should be evaluated on performance, we think you'll agree. But performance is determined by factors which aren't easily checked against service conditions and data. These are the factors we call "hidden values." It will pay you to evaluate these values the next time you specify a compressor. Worthington Corp., Clinton Street and Roberts Ave., Buffalo 5, N. Y. 36-8

WORTHINGTON

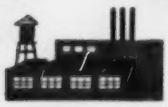
**OPTIC COMPARATOR** is used to check connecting rod bolt threads for uniform angles, lead and form.

**WIRE ALIGNMENT** during assembly using electronic equipment minimizes field alignment problems.

**FACTORY ASSEMBLY** of intercooler and interstage piping reduces installation problems and costs.

**COMPOSITION TEST** determines constituents of molten iron in each ladle before any casting is poured.

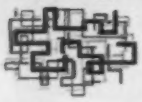
**HONING** of connecting rod crankpin and crosshead pin ends results in tighter fits, no loose shells.



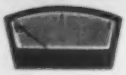
**INTEGRATED DIV.** includes foundry, manufacturing, sales, service and engineering in one location.

**ULTRASONIC TEST**—an advanced method of examining certain critical parts for internal quality.

**$1,000,000 ADDITION TO LABORATORY** assures sound equipment designs based on actual research.



**ANALOG/COMPUTER** simulates wide range of actual operating conditions for optimum design analysis.

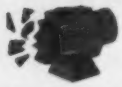


**PROFILOMETER** inspection of highly finished parts assures easy break-in and long life.

**KOLENE PROCESS** removes impurities from bearing shell that weaken bond between it and babbitt.

**CAST-IN LUBE OIL SYSTEM** with internally drilled oil passages eliminates crankcase "plumbing."

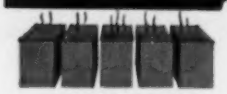
**MAGNAFLUX AND MAGNAGLO** inspections are widely used to expose surface imperfections.



**DESTRUCTION TEST** of complete compressor cylinders verifies engineers' design calculations.

**REMOVABLE DOWEL** locks piston rod to crosshead—prevents turning due to loosened crosshead nut.

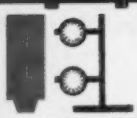
**FINISHED GROUND BEARING SHELLS** provide positive full-contact backing for long life.



**PARCO-LUBRITING** of critical wearing surfaces completely eliminates most start-up scuffing problems.

**FEATHER VALVE**—industry's preferred compressor valve—is efficient, quiet, and low in maintenance.

**STEEL TIE BAR,** keyed and bolted in place, strengthens frame and maintains the original alignment.



**CROSSHEAD SLIPPER ADJUSTMENT** within one-thousandth of an inch assures much longer packing life.

**THERMODYNAMICS SECTION** analyzes each application to size unit and determine its performance.

**SALES AND SERVICE INTEGRATION** recognizes kinship of one to the other. One man administers both.

**ADJUSTABLE ROLLER MAIN BEARINGS** feature low friction losses which help to extend compressor life.

**AIR CONDITIONED GAUGE ROOM** has master gauge blocks constantly used to check instruments.